Atomic Weapons Research Establishment

AWRE

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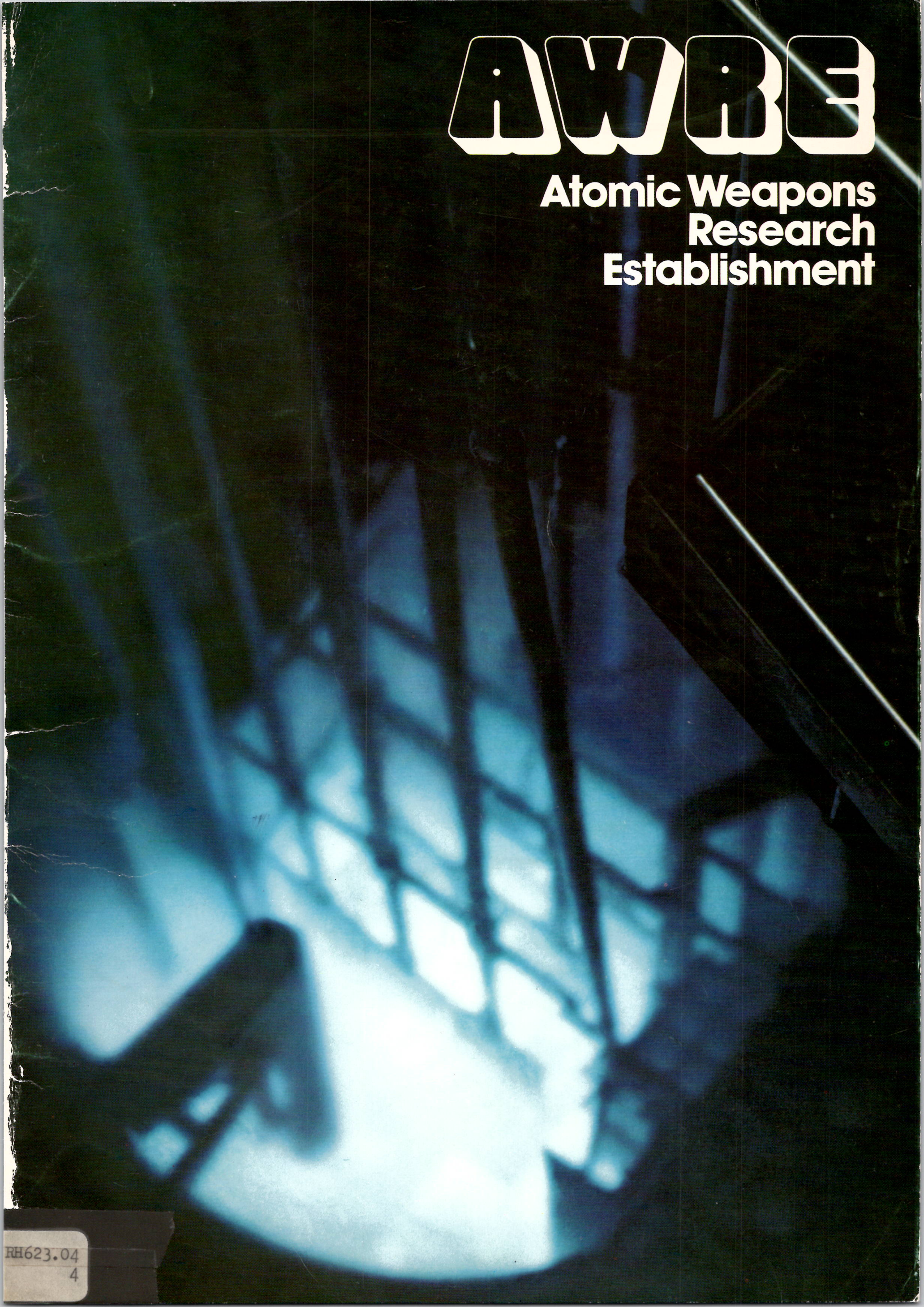

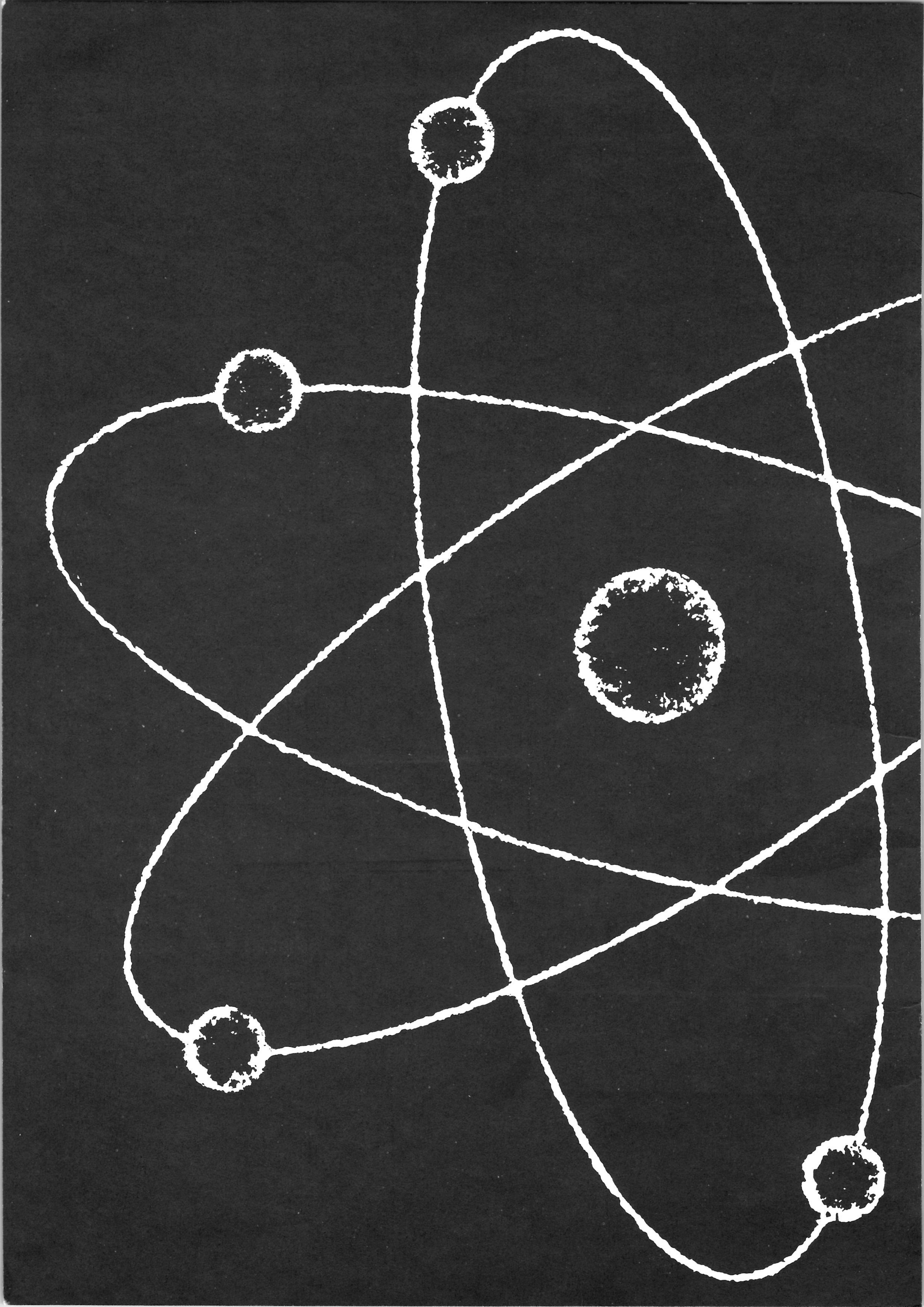

AWRE

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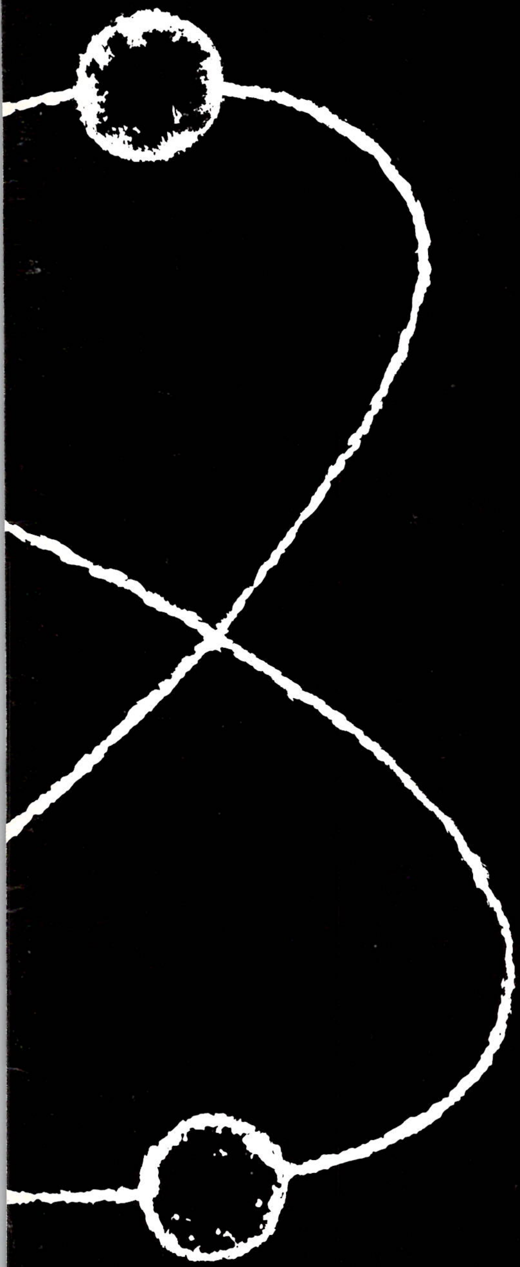

Since World War II Britain has made an important contribution to the development of nuclear science and nuclear engineering. Military research was a forerunner in these modern fields of technology which have made a vital contribution to Western defence in the past three decades.

Being concerned with some of the nation's most closely guarded secrets, the depth and extent of this military programme tends to be obscured but it is always at the advancing fringes of scientific knowledge and the frontiers of developing technology. It is concentrated at the Atomic Weapons Research Establishment which, with its assembly of some of the finest, and often unique, scientific facilities and a multi-disciplinary talent of outstanding breadth, has earned international repute. Its success depends on the contribution of all the staff in a wide variety of grades, both industrial and non industrial.

AWRE — the short title by which it is familiarly known — is a research and development establishment administered by the Procurement Executive of the Ministry of Defence and has a basic function to design and develop the nuclear warheads essential to Britain's nuclear deterrent capability. An important aspect of this function is the collaboration with the United States under the 1958 Agreement on 'The Uses of Atomic Energy for Mutual Defence Purposes.'

In addition to its major role AWRE contributes significantly to many non-nuclear defence projects. Further, where possible, AWRE's expertise and facilities are applied to civil research and development programmes for other Government Departments, Public Bodies and Industry.


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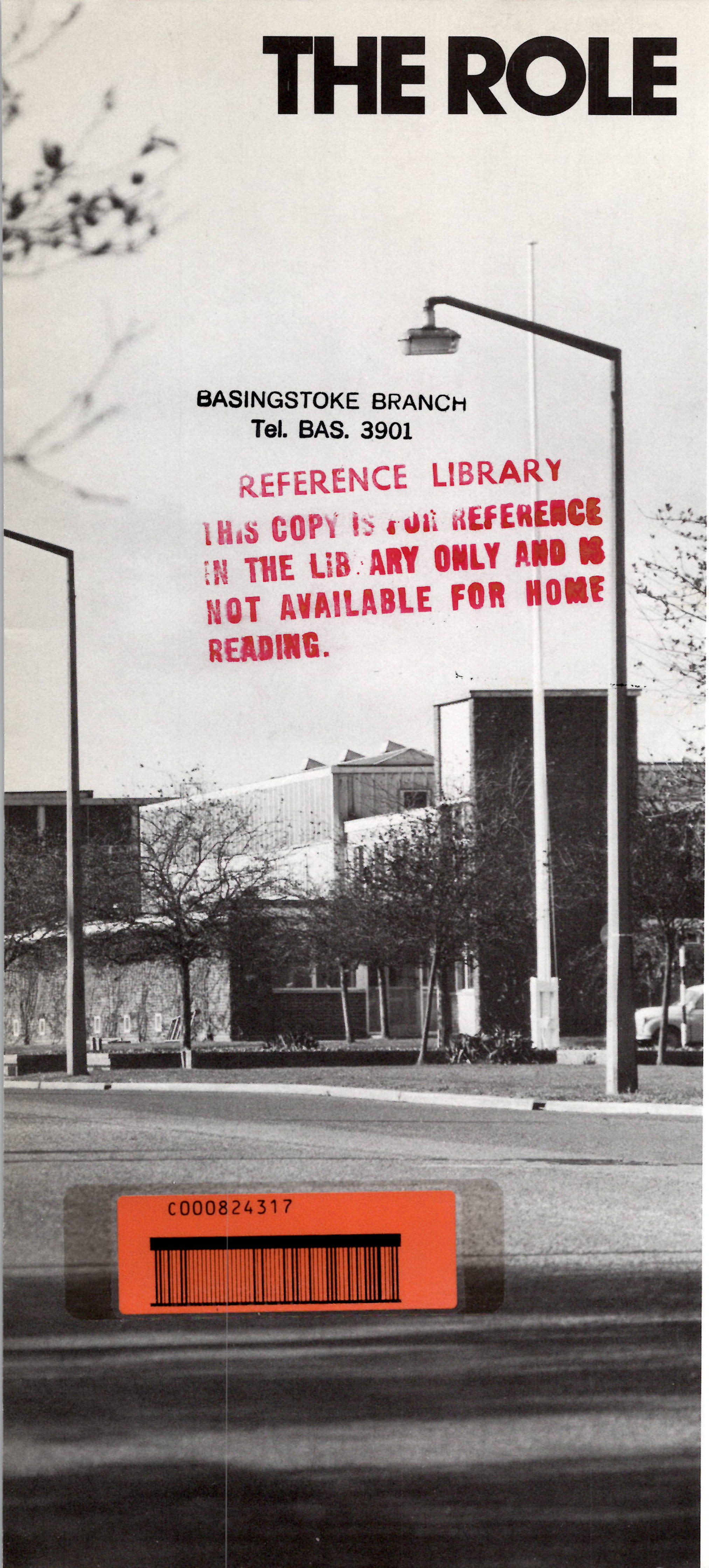
THE ROLE



The British nuclear weapons programme began in 1947 under the leadership of Dr William Penney (now Lord Penney), who was among a team of British scientists associated with the development of the first atomic bombs in the United States during the Second World War. The enterprise was initially co-located at the Armament Research and Development Establishment at Fort Halstead, in Kent, and an out-station at Woolwich Arsenal. Later there were other out-stations at Woolwich Common for weapon electronics production and at Orfordness in Suffolk for the environmental testing of warhead explosive assemblies.

In the early 1950s the work was progressively transferred to the extensive site at Aldermaston, which was being developed as a permanent base for the programme and, at about that time, an open range was established at Foulness Island in the Thames estuary, near Southend-on-Sea, as an out-station for experimentation with chemical high explosive assemblies.

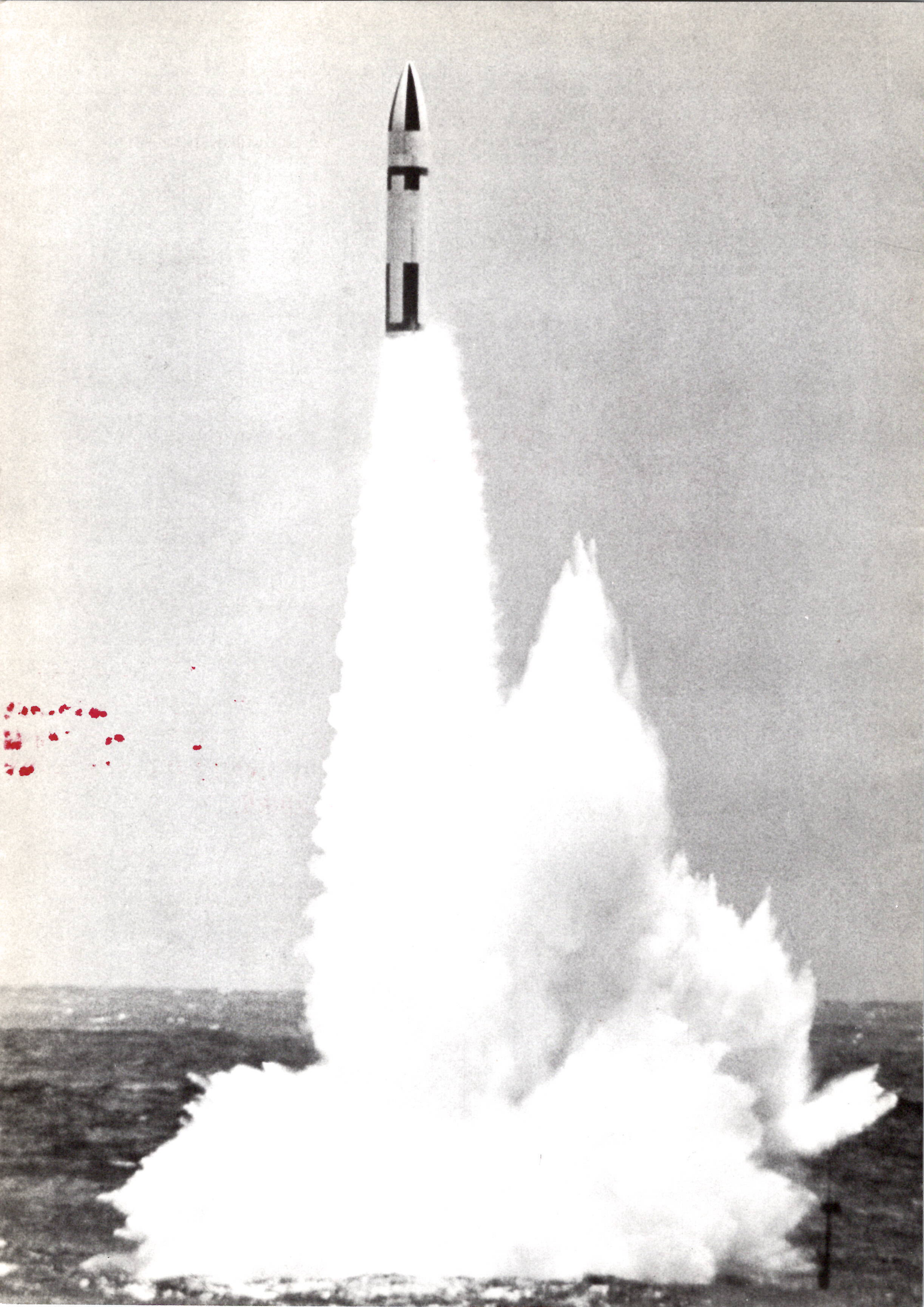
Today AWRE is the town-size complex of purpose-built laboratories, workshops and offices with a large staff of scientists, technologists and supporting categories at Aldermaston, its 'satellite' establishment at Foulness, and a country property, 'Blacknest', near Aldermaston, which is concerned with certain non-secret aspects of the work.

The available facilities are of the highest scientific standards with apparatus and equipment being generally sophisticated, uncommon or unique and with much of it developed and engineered within the Establishment for highly specialised purposes. The overall task is threefold:

Nuclear This is the main programme and is primarily concerned with the design and development of warheads for strategic and tactical nuclear weapons to maintain the effectiveness of the British nuclear deterrent. This includes responsibility for the warheads of the weapons of the Royal Navy's Polaris Submarine Fleet. Some of the major parts of the programme are:

★ post design support for the servicing of nuclear warheads
★ research and development to explore the potentialities of future technologies
★ the research and development of a wide range of materials, including chemical high explosives

The Establishment's main thoroughfare



★ the development of techniques for the detection and identification of both atmospheric and underground nuclear explosions for the purpose of monitoring compliance by States that are signatories to certain Nuclear Test Ban Treaties.
★ the evaluation of nuclear weapon effects on military targets and equipment
★ research and development in connection with radiological defence
★ collaboration with the United States' government under the agreement on the 'Uses of Atomic Energy for Mutual Defence Purposes'.

Non-Nuclear This includes research and development under two principal headings:
★ 'Major Fields' of research which establish the knowledge likely to be needed within the development time-scale of military projects.
★ The subsequent development of these projects.

One of the important tasks is responsibility for a multi-Establishment programme to study the potential, in enemy hands, of high-powered lasers as weapons used against military targets. Another responsibility is the employment of special expertise in theoretical and experimental shock physics for application in the general area of non-nuclear weapon performance, an example being the study of armour penetration. AWRE is now responsible for all MOD(PE) research into chemical explosives with emphasis on power and safety. Expertise in other disciplines finds application in the development of ceramic radomes for guided weapons, window materials for lasers, materials and production techniques for microcircuits, carbon composites for aircraft brakes and rocket nozzles, submarine propeller shaft seals, etc. Assistance is also given to the Royal Armament Research and Development Establishment in the development of bombs for specific purposes using techniques of AWRE origin.

Civil When AWRE's specialised assistance and facilities are available, civil work is undertaken on a repayment basis. For historical reasons the most frequent customer has been the United Kingdom Atomic Energy Authority which has been given substantial support in civil projects, particularly in the development of the prototype fast reactor. The assistance now includes theoretical and experimental studies of reactor safety, the development of instrumentation for fusion experiments and various mass spectrometry services. Other customers include the Department of Health and Social Security, the Scientific Research Council and the Department of Industry. It will remain AWRE's policy to continue this Civil Repayment research and development programme for both Government-based and Industrial customers. A brief description of some of the benefits of such scientific co-operation is given on page 6.

These programmes call for expertise in classical and modern physics, chemistry, materials science, mathematics, electronics and various branches of engineering.

The work ranges from long-term fundamental research, through the development of technology, design, the prototype development of novel systems and the environmental testing of engineered products.

Critical demands are made in nuclear weapon design for stability, strength, safety and compactness. This calls for penetrating and precise research in the field of materials science where the emphasis is on the three recognised nuclear metals, plutonium, uranium and beryllium (for its research and development of beryllium technology AWRE has earned an international reputation), on high explosives and on a wide variety of inorganic and organic artefacts e.g. rubbers, plastics, etc.

AWRE research also studies the physics of the earth's crust in aid of seismic systems for detecting underground nuclear explosions and discriminating them from natural events.

The difficulties of monitoring underground nuclear explosions contributed to the exclusion of underground tests from the Test Ban Treaty in 1963. Since then, however programmes of research to overcome these difficulties have been undertaken in the United Kingdom at AWRE, and at United States research establishments leading to a considerable advance in the study of the science of seismology.

This research is undertaken by the Applied Physics Department (see page 16).

In support of the integral facilities of laboratories and workshops there are a variety of supporting services including: a well-stocked technical library, information services, an extensive computer service (the largest of its kind in Britain) including a site-wide multi-access terminal link system and a Drawing Office.

There are also reactor research facilities to assist in studying the effects of radiation on materials and electronic components. There are two reactors. Herald, the most powerful light-water research reactor in the United Kingdom, is used for neutron activation analysis, for measuring the effects of nuclear radiation on materials and for studying the structure of materials by means of neutron scattering. It is a 5 MW intense source of neutron and gamma radiation and is used by university research teams and other research establishments as well as by AWRE staff.

The second reactor, Viper, is the only one of its kind in Europe. It is a fast-pulsed reactor designed to produce very intense short duration pulses of neutrons and gamma rays with a peak power of 20,000 MW. At present it is being used for many research programmes aimed at the better understanding of the effects of radiation on fissile and non-fissile materials and electronic components.

Test firing of submarine-borne missile

CO-OPERATION

As nuclear partners within the North Atlantic Treaty Organisation, there is a large measure of co-operation between Britain and America. This has included advice and counsel given by nuclear scientists of AWRE to various technical agencies of the US government and in 1977 a particular contribution by one Aldermaston scientist was acknowledged by the US Defense Agency as an achievement of a high order and which reflected credit on the United Kingdom. AWRE also has liaison links with certain other nations in the development of military technology — mainly non-nuclear.

Apart from direct liaison with the Services there is an exchange of information and assistance between AWRE and many other authorities in the United Kingdom in matters which have little or no security sensitivity. This co-operation is with government departments, such as the Department of Health and Social Security, public research authorities and undertakings, such as the Scientific Research Council and the United Kingdom Atomic Energy Authority, and industrial and commercial concerns. This has made possible many scientific advances from the improvement of medical techniques and apparatus to equipment for the Concorde aircraft. Here are some examples:

Aerospace

Research and development of the nuclear material beryllium now used in precision navigational control systems.

Applications to modern aircraft of AWRE research into the fabrication and processing of fibre-reinforced resin and carbon composites.

Research into corrosion and protective chemistry associated with non-metallic materials and coatings.

The design and development of a radiation warning meter used in Concorde aircraft and the calibration of commercially produced instruments with neutron and gamma radiations.

Health

Evaluation of mechanical and corrosive properties of stainless steel and titanium-based alloys used for surgical implants and the development of international standards for implant manufacture.

The study of blood and urine metabolites in uraemic and normal subjects in aid of the development of a transportable artificial kidney machine and the assessment of commercial artificial kidney machines.

Studies of thermographic scanning for diagnosis of breast cancer.

Development of an on-demand pacemaker to maintain the regularity of heart beats.

Studies of the toxicity of plastics used either in the body or in systems connected to the body (eg kidney machines).

Dentistry

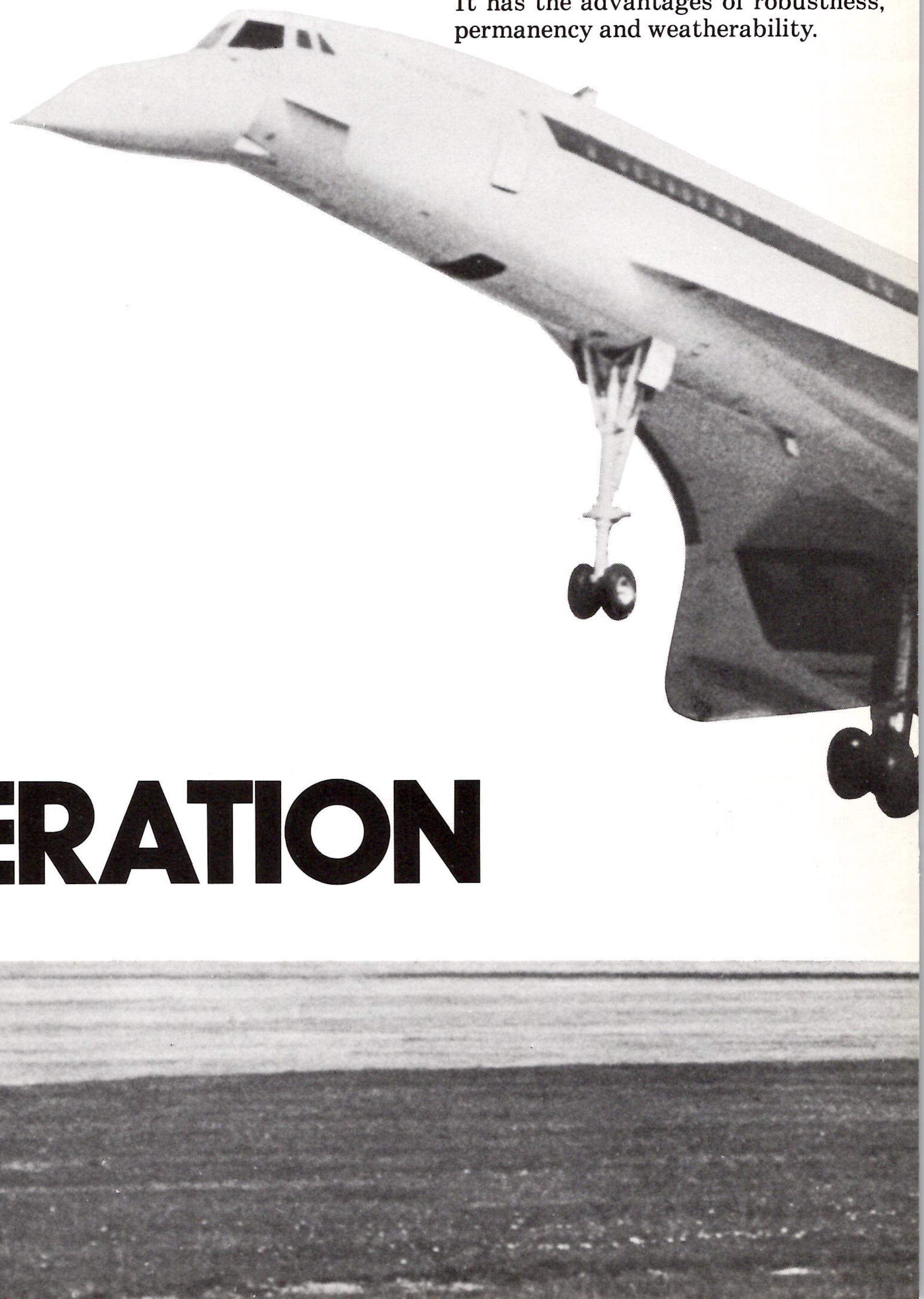
The development of improved materials and the study of dental restoration treatment.

Engineering

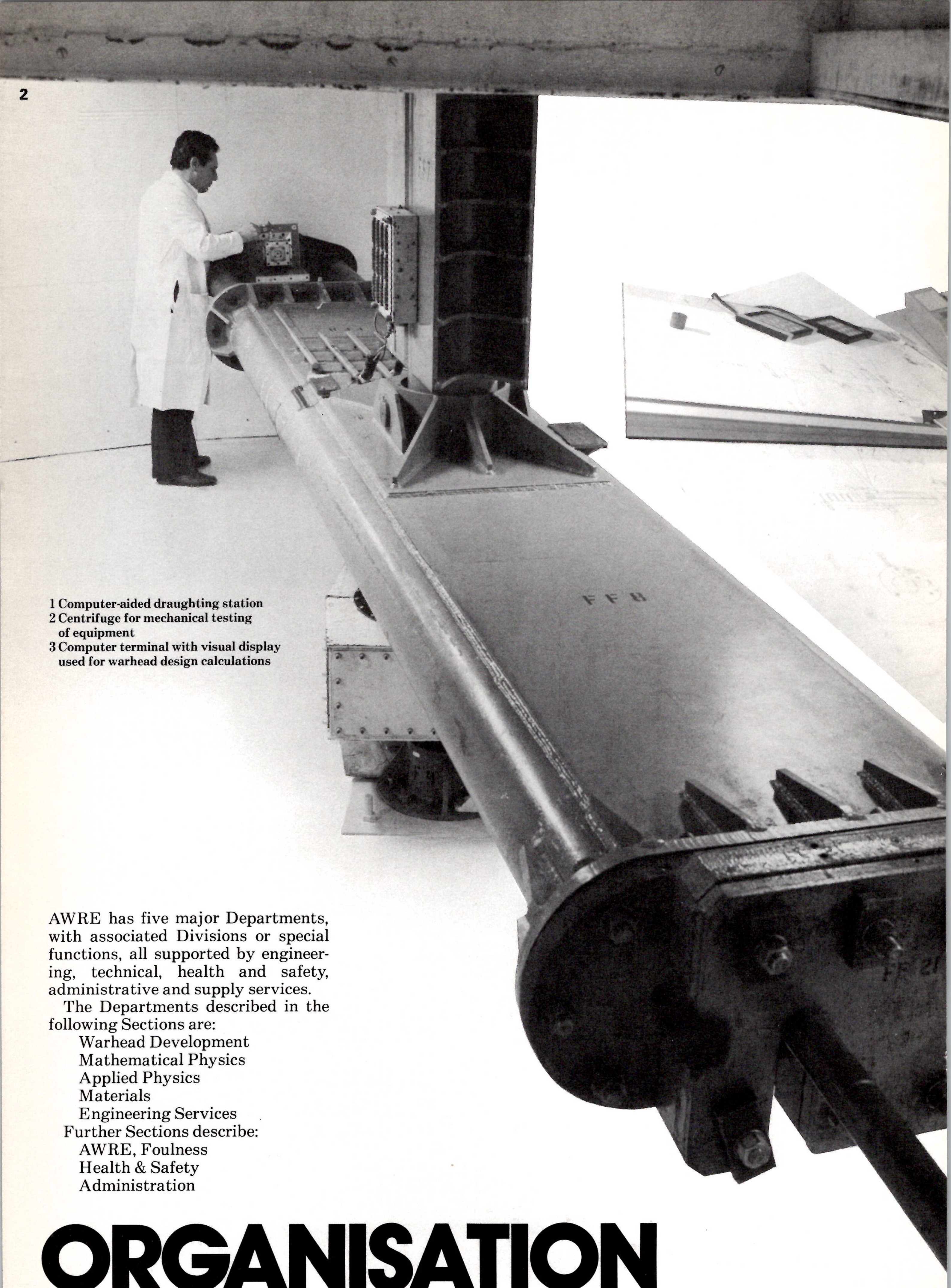
Research into the specific properties of non-metallic materials which has resulted in the application to modern engineering technology of various forms of ceramics, plastics, rubbers, surface coatings and adhesives.

Industrial Safety

The development of an intumescent coating for fire protection which has been applied by an industrial firm under the trade name 'FIREC' to various equipment such as CEGB transit containers, oil rigs and vessels for containing hazardous chemicals. It has the advantages of robustness, permanency and weatherability.



1 Artificial kidney machine on test
2 Diagnostic equipment for detection of breast cancer
3 "Equipment for the Concorde"



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1 Computer-aided draughting station
2 Centrifuge for mechanical testing
of equipment
3 Computer terminal with visual display
used for warhead design calculations

AWRE has five major Departments, with associated Divisions or special functions, all supported by engineering, technical, health and safety, administrative and supply services.

The Departments described in the following Sections are:

- Warhead Development
- Mathematical Physics
- Applied Physics
- Materials
- Engineering Services

Further Sections describe:

- AWRE, Foulness
- Health & Safety
- Administration

ORGANISATION

WARHEAD DEVELOPMENT

1

Weapon Design

This Division takes the ideas and experimental findings of scientific Divisions and turns them into practicable designs for military equipment to meet the operational, safety, financial, and timescale requirements of the Services. It also provides project leadership and co-ordination. The principal discipline is mechanical engineering, supported by a complementary function in the Weapon Electronics Division. Detailed designs and performance and process specifications are provided by a Drawing Office which is fully acquainted with design standards for military equipment and the special engineering characteristics of unusual materials used in nuclear components. Two-thirds of the staff in the Division work in the Drawing Office but the Office not only serves Warhead Development but the whole of AWRE. It works through the main disciplines of mechanical design, electronics, electrical engineering, building, etc. It has a Design Standards office and training facilities to ensure the highest standards of design capability among its staff. It also develops modern systems to improve its efficiency, particularly in computer-aided draughting and interactive graphics.

A specialist group is concerned with advanced methods of stress analysis, relevant computer code development, and the co-ordination of complex experiments to determine the effects of unusual loads — particularly transient ones — on compound structures. Another specialist group is concerned with advanced or unusual mechanical designs and their evaluation. Engineers maintain close technical and programme links with workshops in AWRE and with production organisations in ordnance factories and elsewhere. The engineers also take part in trials to evaluate weapon systems. Comprehensive environmental test facilities are manned by staff which has access to specialist scientific test facilities elsewhere, sometimes overseas.

Weapon Electronics

This division is responsible for the research and development of electronics associated with nuclear weapons. This embraces conventional

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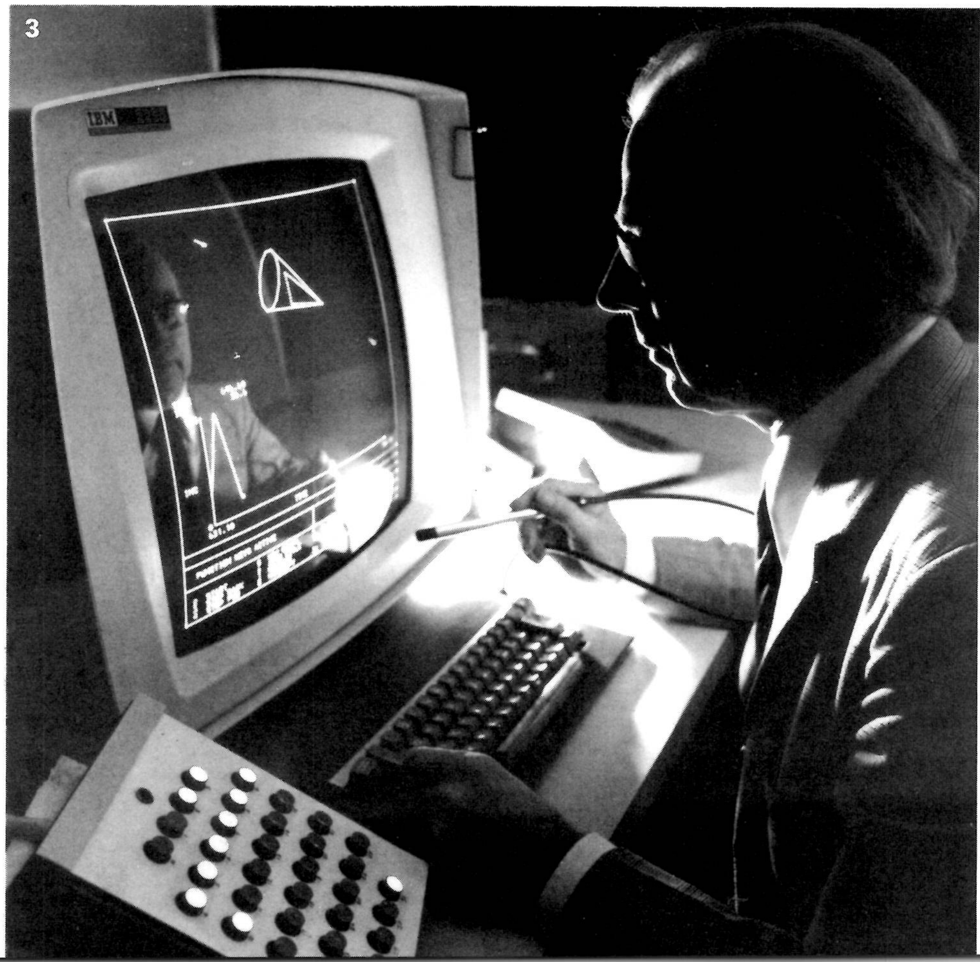

electronics components, large-scale integrated circuits and microprocessors, and special purpose components, all of which must function reliably after long periods of storage. Very high standards of design and manufacture are needed to ensure reliability and safety under difficult environmental conditions, including nuclear radiation. There are complex security and safeing arrangements to protect weapon systems.

A further function is the coordination of work throughout AWRE on the effects of nuclear weapons on conventional military systems and vital civil communication systems. To this end there is research and development of electromagnetic pulse effects and transient radiation effects in electronics with a view to producing circuits and devices which will survive a nuclear attack.

The division has two branches, one dealing with research and development and the other with project engineering, developing systems and progressing them to production stages. Special facilities include full-scale vertical and horizontal electromagnetic pulse generators, high grade vacuum physics process laboratories, pulse X-ray facilities and a special scanning electron microscope for large-scale integration investigation. Extensive use is made of mathematical models for system design, and evaluation and the necessary programs stretch even the site computer to the limit of its capacity.

Assembly

Conventional explosives play an important part in the design of a nuclear weapon. The chemical energy released by the explosive reaction is used to change the fissile material from its safe resting configuration rapidly into an adequately supercritical state. To make the best use of the space available for conventional explosive, the designer of nuclear weapons needs, firstly, to store chemical energy as compactly as possible and, secondly, to use this stored energy as efficiently as possible in moving, reshaping and compressing the nuclear explosive components. The Division's main function is to provide the expertise and facilities needed to satisfy the second of these two requirements.

This involves the study of the propagation of detonation waves in high explosives, the properties of the detonation products, and the behaviour of materials under rapidly applied high stresses, especially the detailed motion, fracture or change of state which are thereby induced in

1

them. Specialised experimental techniques are needed in these studies, many of which relate to phenomena occurring on a microsecond or submicrosecond time scale. Electronic, optical and radiographic techniques have been developed and are continually being improved. Sub-microsecond high-penetration flash-radiography is particularly important to the work of the Division and powerful advanced X-ray machines of this type have also been developed; the expertise thereby acquired in producing short-duration high-current discharges and in controlling intense electron-beams has found other important applications within and outside the nuclear weapons field.

Experimental work is supported by, and interpreted by means of, computational capabilities. Though these are primarily provided by the Mathematical Physics Department, Assembly Division plays an active role in adapting hydrodynamic codes to cope with particular types of configuration and in providing the data on properties of materials and explosives performance on which any hydrodynamics code needs to operate.

Although most of the Division's work is oriented towards nuclear weapons, support is given to other Defence Establishments concerned with the optimisation of non-nuclear armaments, where problems involving sophisticated use of explosives or response of materials to shock-loading increasingly arise.

Special Projects

This Division provides systems and project management expertise for the whole Establishment. It employs staff with expertise in pure and applied sciences and various branches of engineering. The staff co-ordinate technical work required for major weapon projects, undertake systems studies and control production of Approval documentation. In addition they undertake forward-looking systems studies to advise senior management of suitable research and development areas. Feasibility studies on future weapon systems and detailed planning during project definition phases are also important parts of the work.

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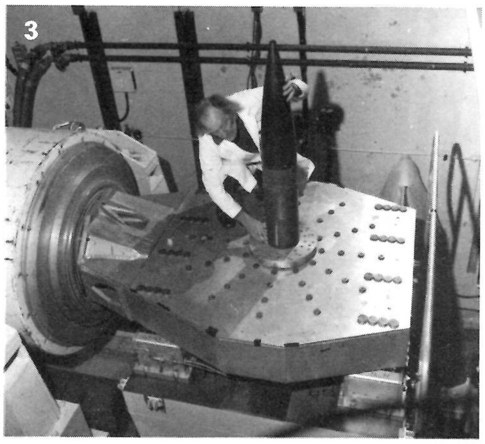

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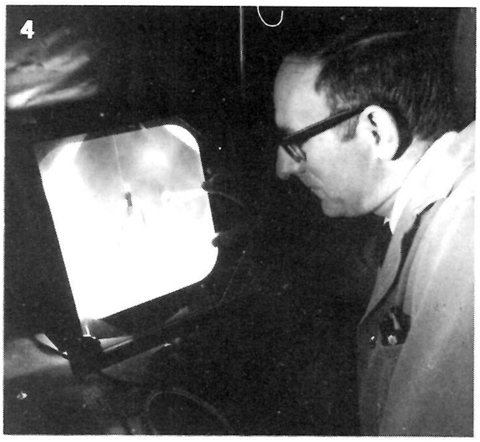

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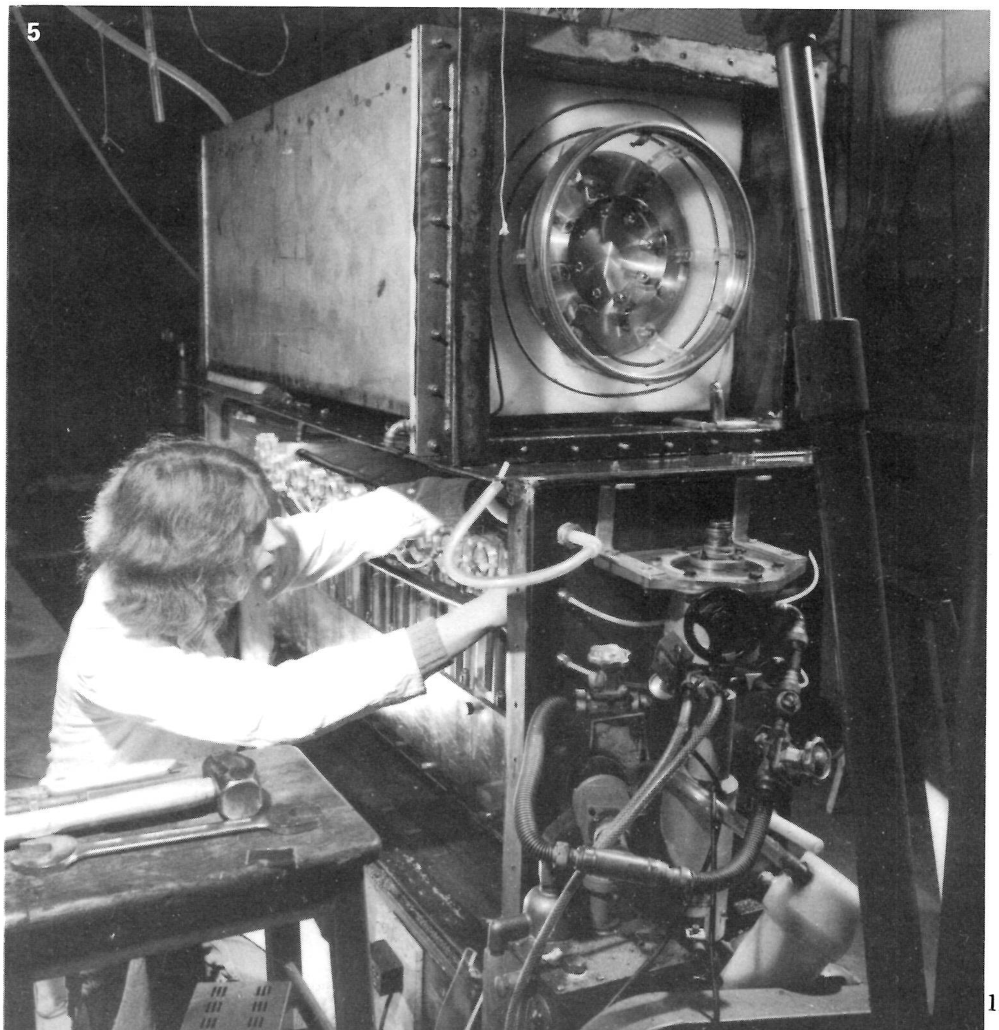


1 Missile being prepared for test in external electromagnetic field
2 Capacitor bank providing large pulses of energy
3 Missile being set up for vibration test
4 Study of strains in complex shapes by polarised light
5 Short-pulse 1-Mev flash X-ray facility

MATHEMATICAL PHYSICS

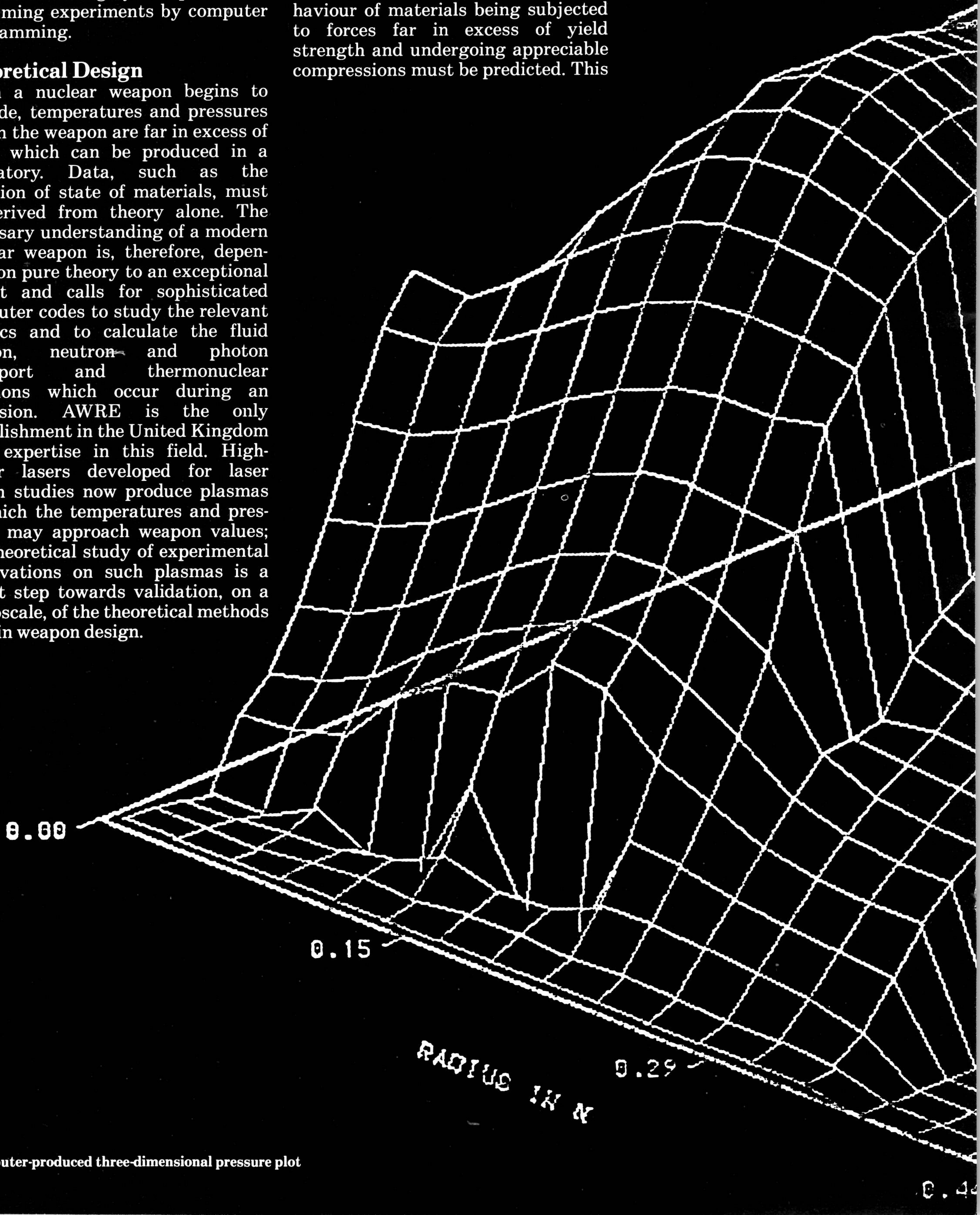
Mathematical physics includes aspects of astro-physics, neutron transport, fluid dynamics and the simulation of highly complex time-consuming experiments by computer programming.

Theoretical Design

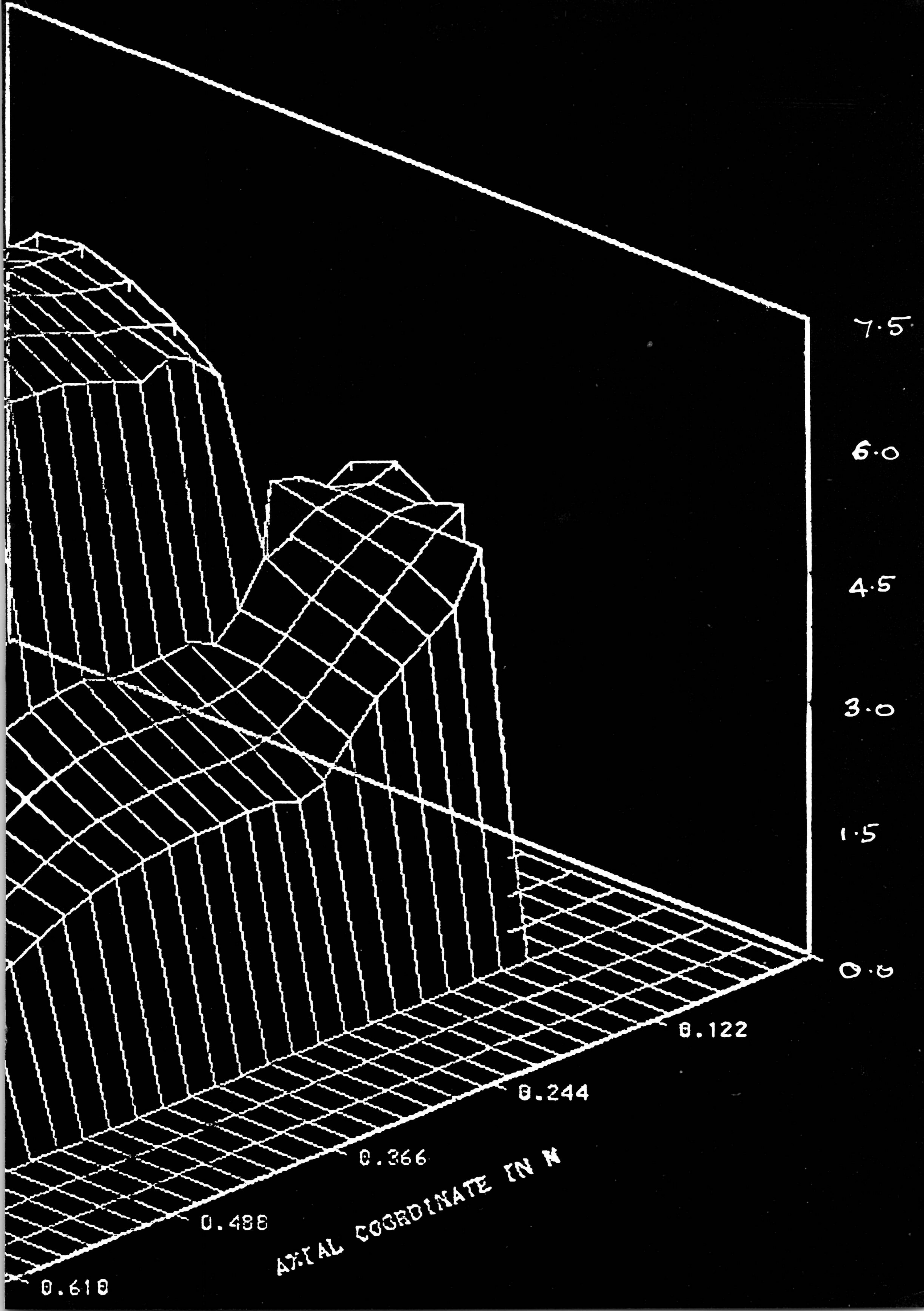
When a nuclear weapon begins to explode, temperatures and pressures within the weapon are far in excess of those which can be produced in a laboratory. Data, such as the equation of state of materials, must be derived from theory alone. The necessary understanding of a modern nuclear weapon is, therefore, dependent on pure theory to an exceptional extent and calls for sophisticated computer codes to study the relevant physics and to calculate the fluid motion, neutron and photon transport and thermonuclear reactions which occur during an explosion. AWRE is the only establishment in the United Kingdom with expertise in this field. High-power lasers developed for laser fusion studies now produce plasmas in which the temperatures and pressures may approach weapon values; the theoretical study of experimental observations on such plasmas is a recent step towards validation, on a microscale, of the theoretical methods used in weapon design.

Fluid Dynamics

To assess the performance of nuclear weapons, or even those involving only normal chemical explosives, the behaviour of materials being subjected to forces far in excess of yield strength and undergoing appreciable compressions must be predicted. This



Computer-produced three-dimensional pressure plot


7·5
6·0
4·5
3·0
1·5
0·0
0.122
0.244
0.366
0.488
0.610
AXIAL COORDINATE IN M

is a problem in compressible fluid dynamics. Equations governing the conservation of mass, momentum and energy for unsteady compressible fluid flow in one or more space dimensions are well established but their application in realistic geometries, particularly with complicated boundary conditions, is less well developed. Several approaches have been followed. Methods used to solve these problems include that of characteristics in one space dimension and time, and finite difference methods in both one and two dimensional unsteady flow. The latter have been developed in both Lagrangian and Eulerian frames of reference.

If stress levels are relatively low, the shear strengths of the materials may have significant effects on the flow and the simple hydrodynamic approximation of perfect fluids become inadequate. In these cases stress is considered as the sum of an isotropic hydrodynamic pressure and a stress term which varies with direction. These can be linked appropriately and given boundary values so that the motion of a full elasto-plastic material can be determined.

In addition to the above effects, at high temperatures it is often necessary to consider the loss of energy by radiation. For problems involving fissile material the migration and interaction of neutrons in the various materials is taken into account. A complete calculation may involve several interacting physical phenomena and become highly complicated and demanding of computer power.

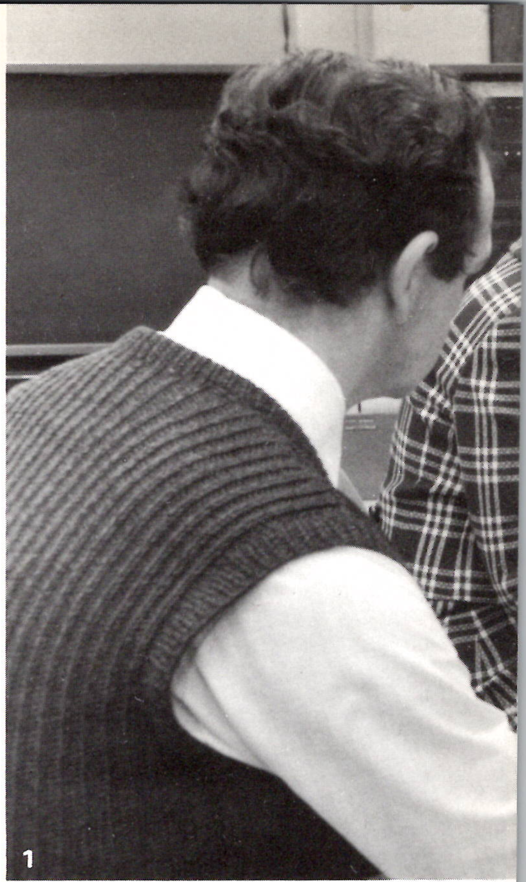
Computing

As cost, and political and environmental considerations, call for experimental work in nuclear weapons to be minimised, mathematical physics theory and numerical computation play a prominent part in the development of these weapons. At AWRE the demand for computer power exceeds the supply and the latest and most powerful computer available is used.

In assessing the results of mesh-type computations, such as those associated with hydrodynamics, a particularly useful role is played by computer graphics. Some 2000 pictures a day are produced on an electrostatic printer, with a turnround time that keeps pace with line printer output. A remote terminal system has existed within the Establishment since 1967, and now comprises about 80 terminals, linked to the central computer. There are also more than 50 smaller computers in AWRE earmarked for experimental and data collecting facilities.

Special Methods

Other problems in mathematical physics, for example the behaviour of a gas, involving the consideration of the motions and interaction of hordes of elementary particles — molecules, atoms, electrons, or neutrons are often solved by even more sophisticated methods. Sometimes sets of equations are too large to be solved by any existing computer. It may then be more practical to adopt special methods, such as the Monte Carlo approach, which considers a sample of individual particles and processes each in turn in accordance with its appropriate physical law. The effect for each particle is 'a random walk' much as a bagatelle ball impacts on pin after pin, changing its velocity and direction at each collision. The chief application of the Monte Carlo method to AWRE problems is in the neutronics field, an example being the calculation of the penetration of neutrons through blocks of screening material in awkward geometry.



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1 Computer console
2 General view of computer room
3 Graphical output (pressure and velocity distributions) from eulerian hydrodynamic code

2


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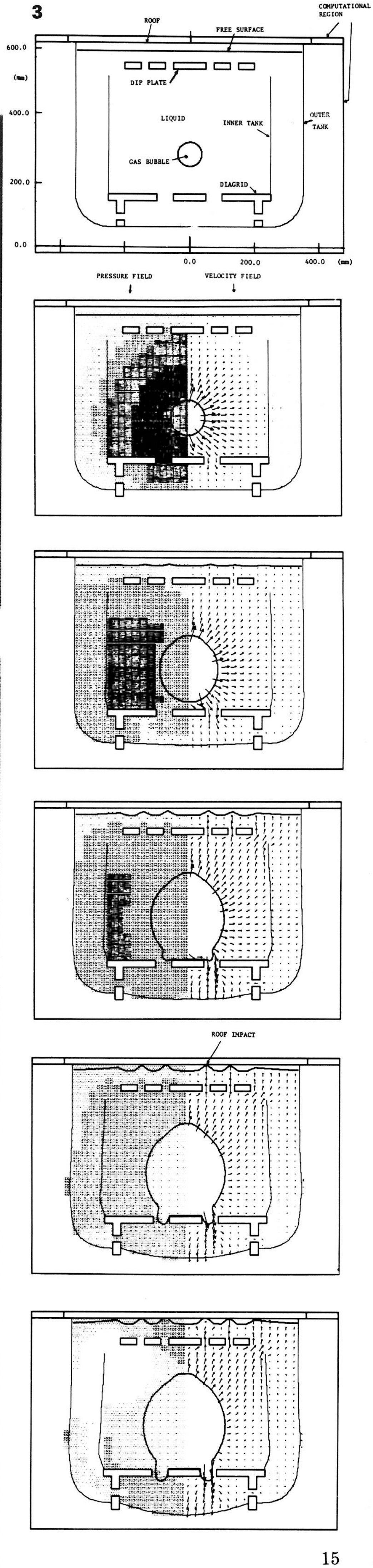
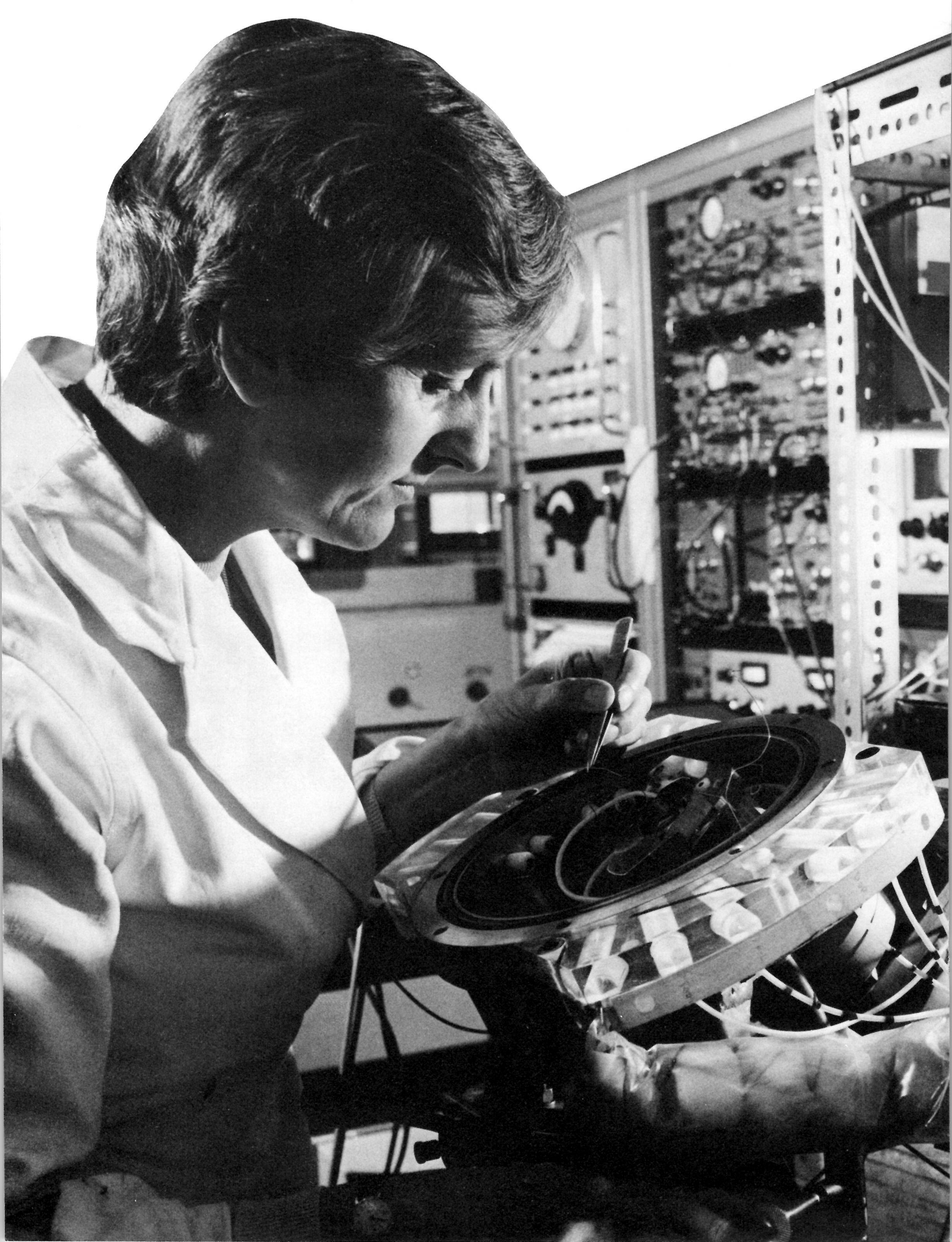
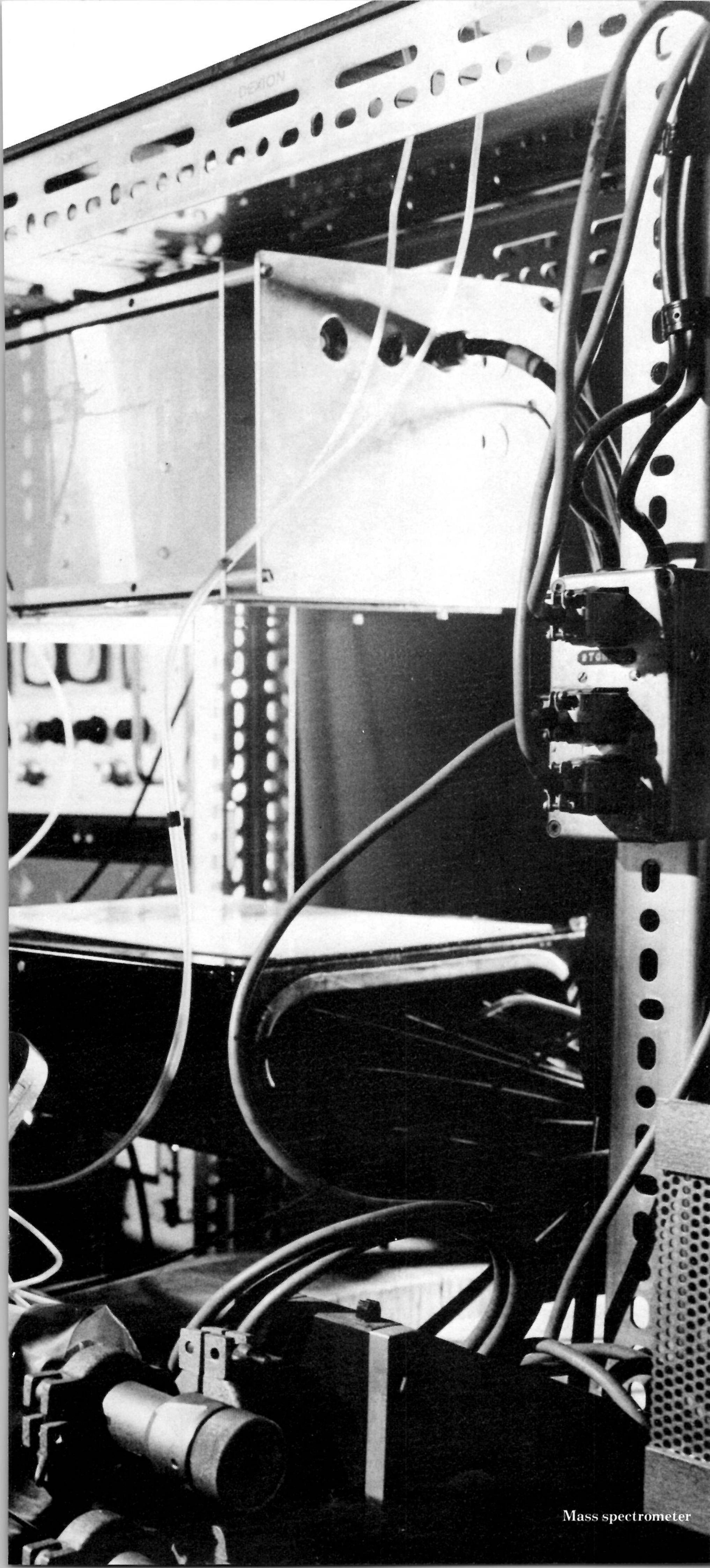
IBM

3


COMPUTATIONAL REGION
ROOF
FREE SURFACE
600.0
(mm)
DIP PLATE
400.0
LIQUID
INNER TANK
OUTER TANK
GAS BUBBLE
200.0
DIAGRID
0.0
0.0
200.0
400.0
(mm)
PRESSURE FIELD
VELOCITY FIELD
ROOF IMPACT

APPLIED PHYSICS





Mass spectrometer

Applied physics is concerned with the development and deployment of measurement and communication systems, and specialised optical-mechanical and electronic equipment. Much expertise was acquired in meeting the exacting requirements of nuclear weapon tests, the timescales of which are measured in nanoseconds (ie thousandth of a milli second). Such tests — now less frequent than formerly, as all but underground nuclear tests have been prohibited for many years in the US, USSR and the UK — pose challenging problems in the accurate measurement of the rapidly rising X-ray, gamma and neutron emissions under adverse environmental conditions. They also call for the development of a variety of special detectors in collimated lines of sight with careful screening from adjacent detectors and unwanted radiation. Associated electronic recording systems use advanced analogue and digital technology, with ultra high-speed multi-channel oscillographic systems and digital systems capable of responding to the rapidly rising waveforms. An important part of the work is the analysis of the recorded data.

Since the Nuclear Test Ban Treaty came into operation the Applied Physics Division has played an important part in monitoring compliance with this Treaty, using several detection techniques. Negotiations for a comprehensive test ban treaty now aim to include underground nuclear tests for which seismic signals offer the only means of detection, location and identification. For many years a research programme on seismology has been carried out with the objective of advising the Government on technical aspects of problems caused by earthquakes and intermittent ground movements which interfere with the identification of man-made explosions. Research is aimed at understanding and compensating for the effects of geologic structures on seismic waves, improving signal-to-noise ratios by means of seismometer arrays and improving the resolution and reliability of the recording systems. Magnetic tape recordings from several arrays at home and overseas are received at AWRE. General purpose as well as dedicated computing and analysis systems are employed in processing and analysing the data.

A wide range of electronics and communications work is carried out. Where minicomputers are incorporated into the system designs, appropriate hardware and software skills have been developed. Microprocessors are used extensively instead of special-purpose hardware,

to save both time and cost. A cell library system permits integrated circuits to be manufactured to AWRE designs, and in this and other ways exceptionally high degrees of miniaturisation are obtained.

The Division is recognised for developments in precision engineering and the manufacture of prototype electronic and opto-mechanical equipment. Much of the opto-mechanical effort supports laser programmes and involves the design and manufacture of specialist optics and optical systems with high-precision mountings and controls. The development of new and complex electronic techniques is supported by facilities such as a Calma interactive computer graphics facility and photoplotter, a thick film manufacturing facility, automated test equipment and well-equipped workshops.

The Division also makes an important contribution to medical science as indicated in the Section 'International and National Co-operation' (see page 6).

Nuclear Applications

The effects of nuclear weapons radiation on materials are studied using powerful electron beams to simulate the effects of X-radiation and using the Aldermaston nuclear reactors to study the effects of neutrons. The reactors are also applied to studying other material properties, such as the use of neutrons for radiography (this can reveal details not visible in X-radiographs) and to the characterisation in a non-destructive way of the micro-structure of components, such as in turbine blades. Another aspect of materials studies is mass spectrometry — for the analysis of organic and inorganic materials, including gases.

There are two programmes of laser applications. One is to evaluate the use of high-power lasers as weapons e.g. to destroy missiles. The other is concerned with nuclear research. These laser programmes are supported by a specialist optics team which also contributes to the general optical needs of AWRE, such as for optical metrology and studies of thermal radiation effects of nuclear weapons.

1 Setting up a laser experiment
2 Adjusting a mass spectrometer
3 Seismic recording equipment developed at AWRE.
4 Taking measurements on a seismograph record
5 Laser/plasma interaction using 100-GW pulsed laser

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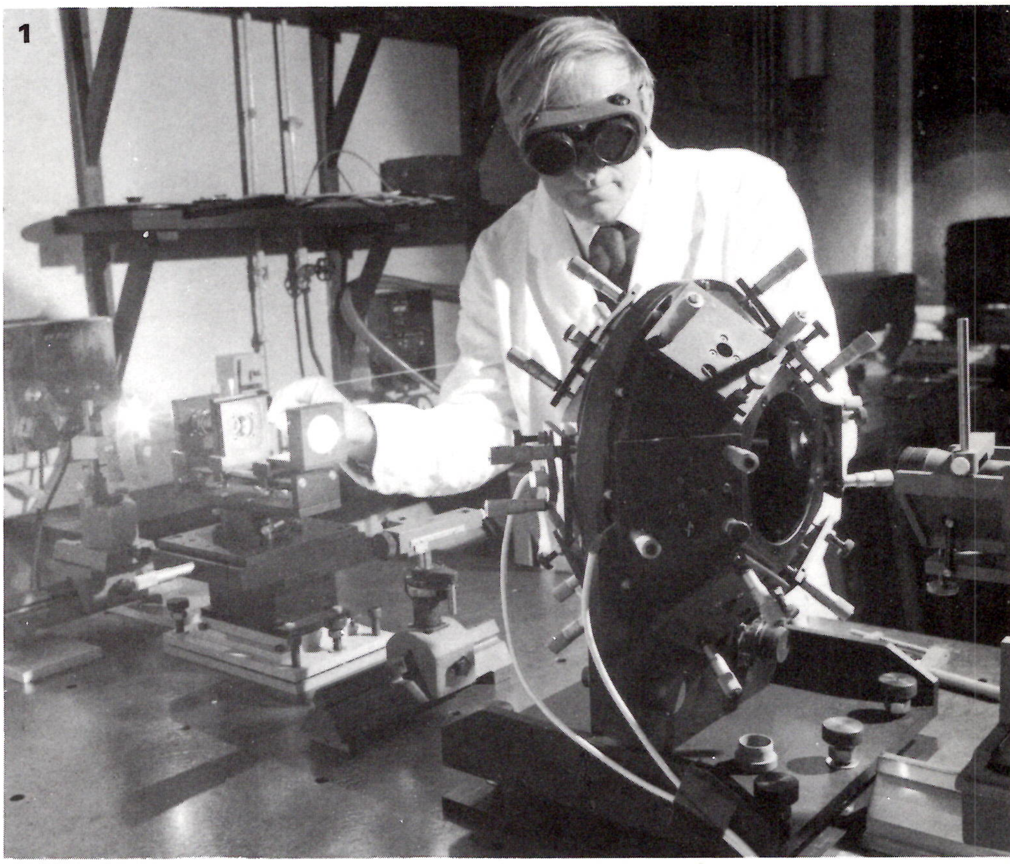

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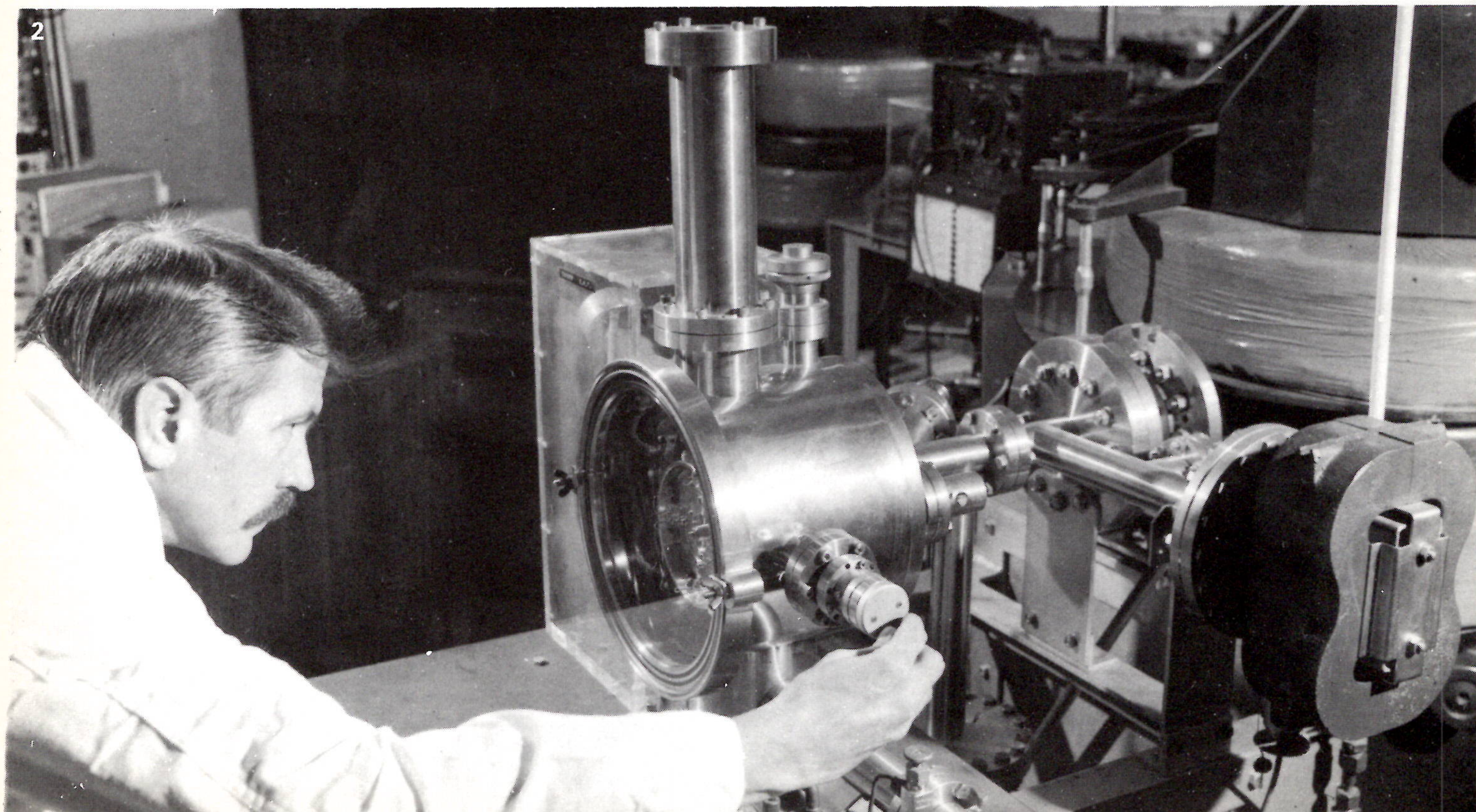

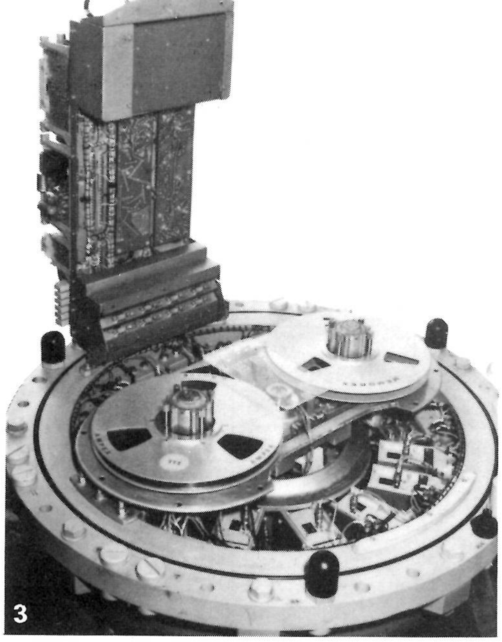

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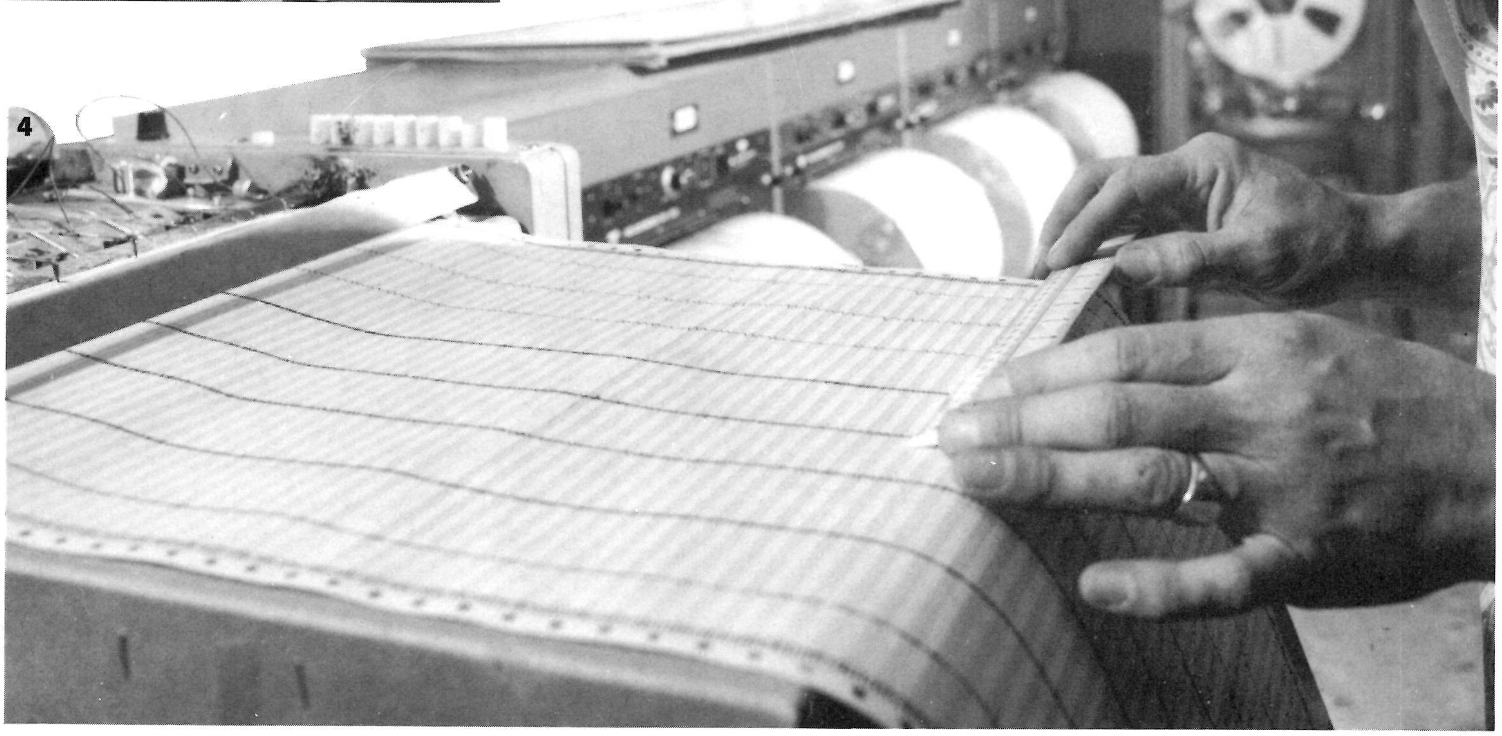

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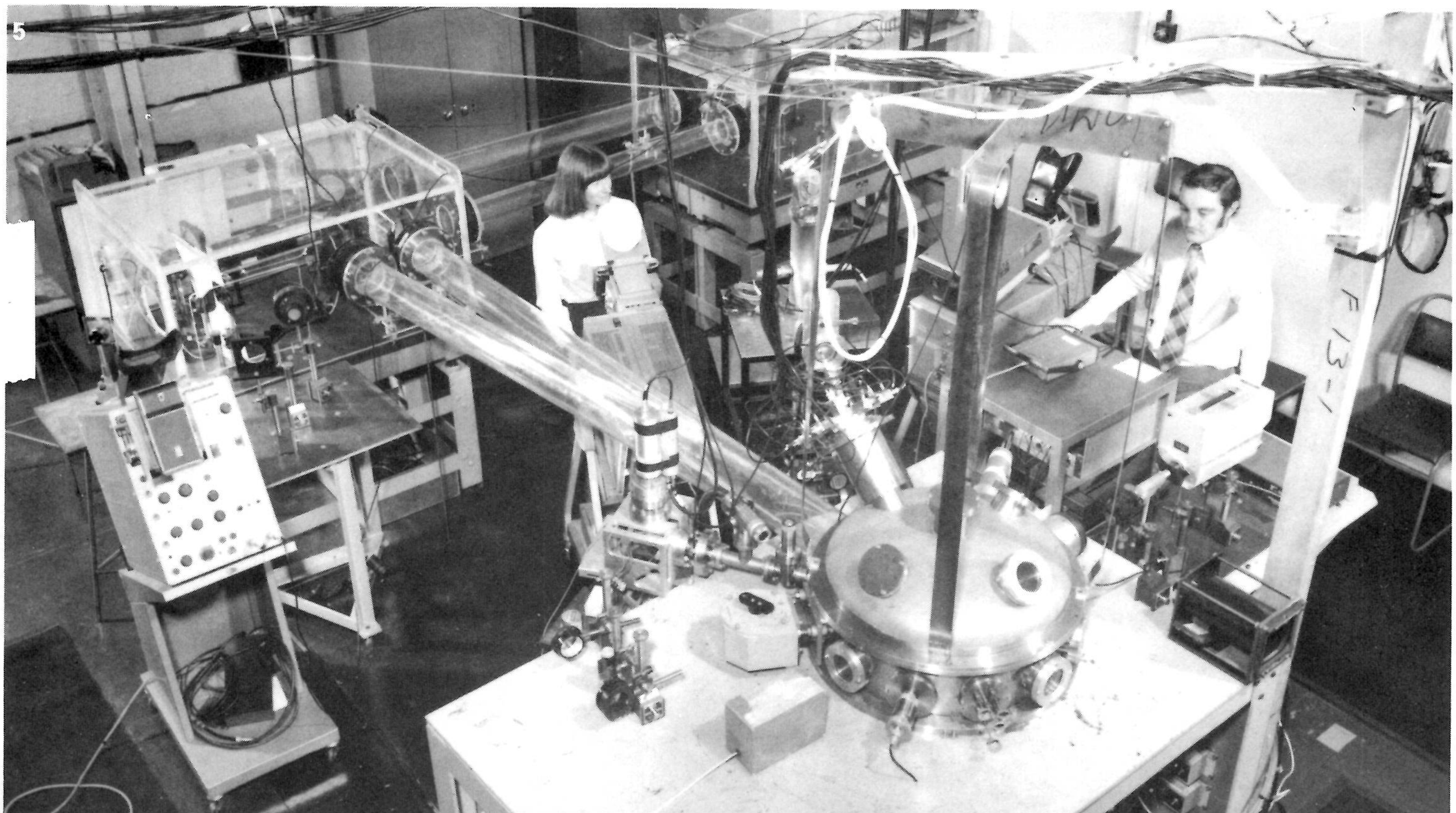


5

MATERIALS

Programmable machine for winding hollow axi-symmetrical fibre composite shells

Materials Department has four Divisions, namely Chemistry, Chemical Technology, Explosives and Metallurgy. The role of the Explosives Division now includes high explosive research for the MOD as a whole.

Chemistry

Chemistry Division works in many fields. Most of it is in furtherance of the weapons development and production task but the complexity of it is such that there are major and varied efforts in physical and inorganic chemistry, supported by an advanced analytical capability.

There is a varied programme of chemical research, most of it concerned with the handling of radioactive solids, liquids and gases and their processing under exacting conditions of containment in the production of uncommon and potentially hazardous substances. A large group works on chemical aspects of materials science, where the aim is the development and characterisation of materials for specific demanding applications and for the improvement of understanding of the interaction of these materials with each other and the environment. This work includes both the production of small amounts of unusual materials and fundamental studies of the chemistry of substances. Expertise has been developed in advanced radiochemical techniques in support of weapon test diagnosis.

The work caters for the needs of the Establishment as a whole and is supported by an analytical branch. The Herald reactor and a 14 MEV neutron generator are used to provide a neutron activation analysis service and, in addition, there is a programme of analytical research and development.

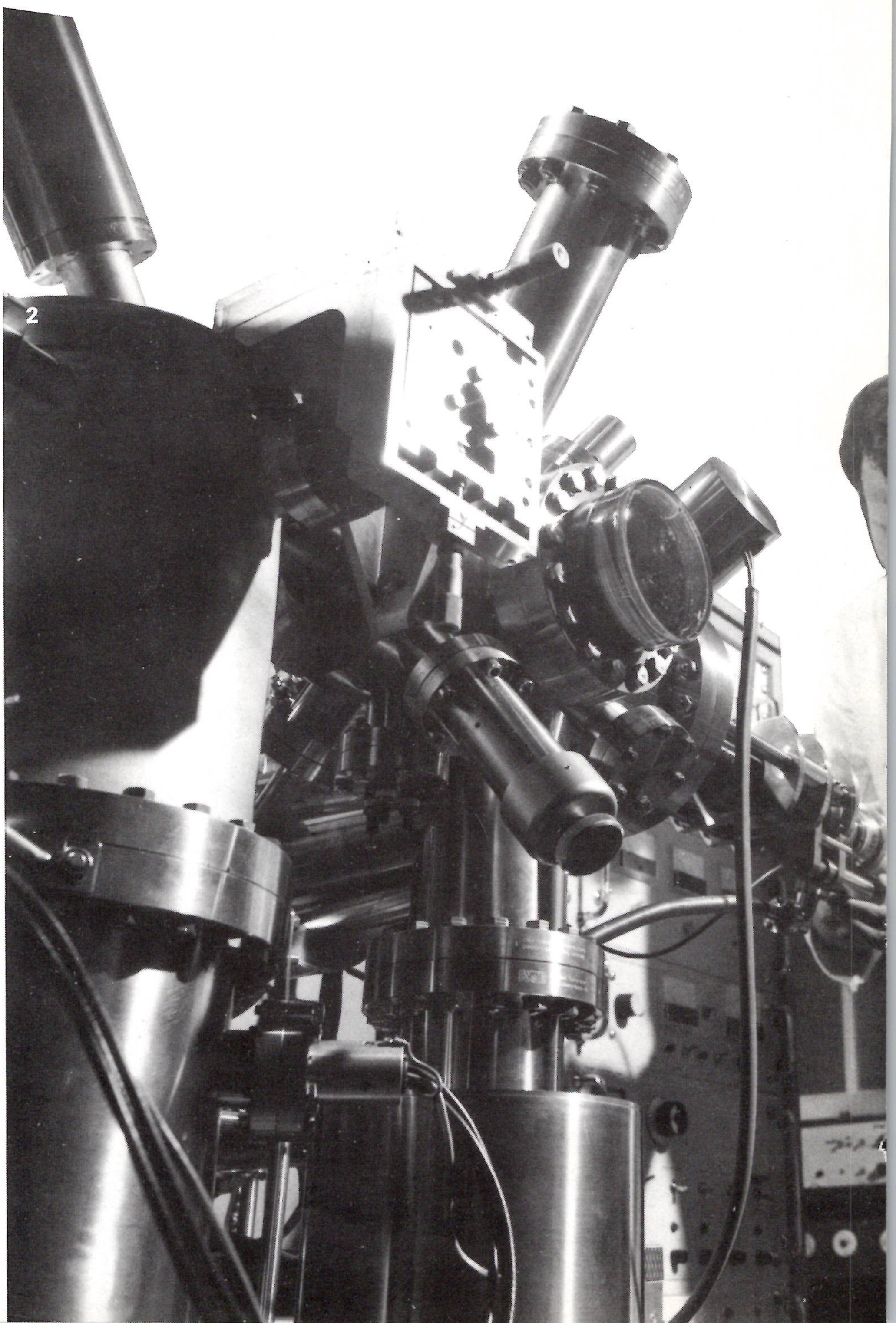
The Division is also involved in work for other Ministry of Defence, Government and non-governmental authorities and this work includes biomedical, geochemical, dental and other non-nuclear projects.

Chemical Technology

Non-Metallic Materials Science and Technology This branch is concerned with the application to modern engineering technology of (a) the more conventional forms of ceramics, plastics, rubbers, surface coatings and adhesives, and (b) advanced composite material. This involves the understanding and development of fibrous and non-fibrous composites using a variety of matrices, including ceramics, carbons, cross-linked resins and rubber-like polymers; and structure/bulk property relationships based on the constituent properties and their geometrical and volumetric distribution. The properties sought include the elastic constants, thermal expansivity, and various transport phenomena, including electrical conduction, heat conduction and permeability. Materials characterisation, behaviour in hostile environments, and long-term stability are also important aspects of the work.

Going hand in hand with the fundamental understanding of composite materials is the advancement of technological processes to convert them into engineering end products. There are basic studies and development work on such topics as filament winding and lay-up techniques for forming uniform shells of solid revolution; formation of 1-, 2- and 3-dimensional structures from high strength filaments; interaction at solid/liquid and solid/solid interfaces and adhesive mechanisms; mixing and rheology of highly filled polymers for high temperature applications; network formation in cross-linked polymers; thermal analysis; carbonisation techniques; plasma spraying; powder compaction involving sintering and hot pressing; decontamination; chemical vapour deposition; and the development of low density, high strength materials based on foamed and honeycomb structures.

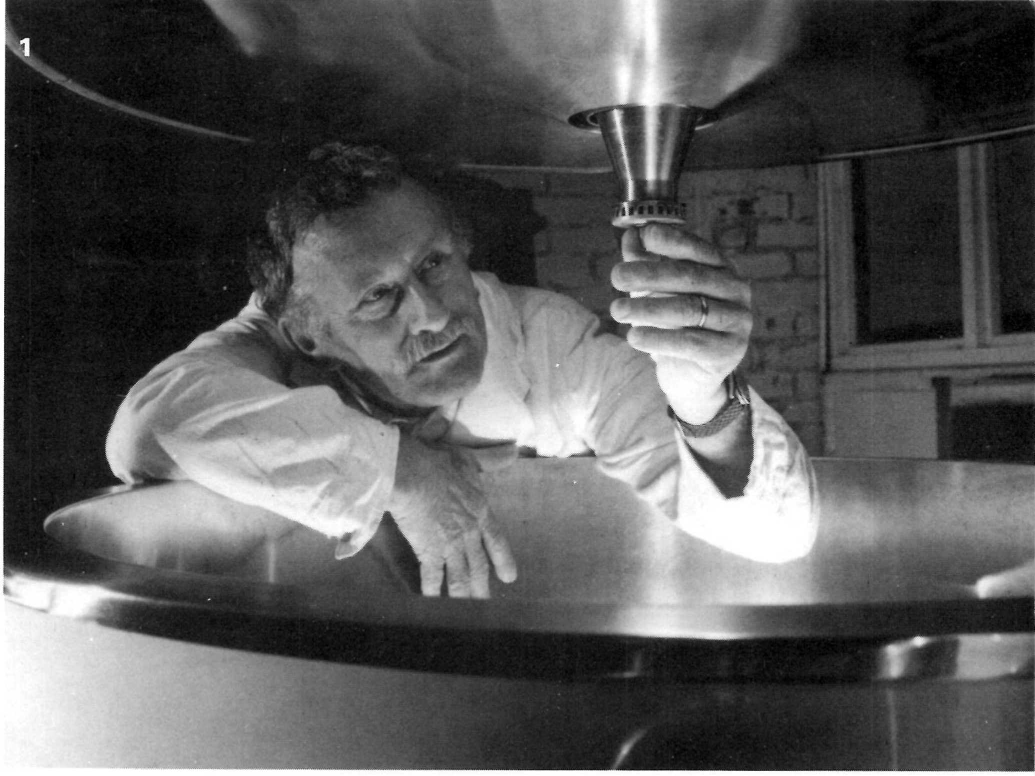
Chemical Engineering and Chemical Plant Operations A major task of this branch is the development and design of facilities for the treatment of plutonium and plutonium contaminated materials. A specialised Section is responsible for taking



laboratory studies to the design, commissioning and operation of full-scale plant. Their work entails the fabrication and processing of fibre reinforced resin and carbon composites for advanced aerospace application and processing of a wide range of particular composite materials for use in weapons technology; the operation of gas purification plants throughout the Establishment to ensure work-box atmospheres of high purity for the processing of radioactive, toxic, pyrophoric, and chemically reactive materials; the safe treatment and disposal of radioactive and other waste materials. In all these operations emphasis is on safety, close process and quality control.

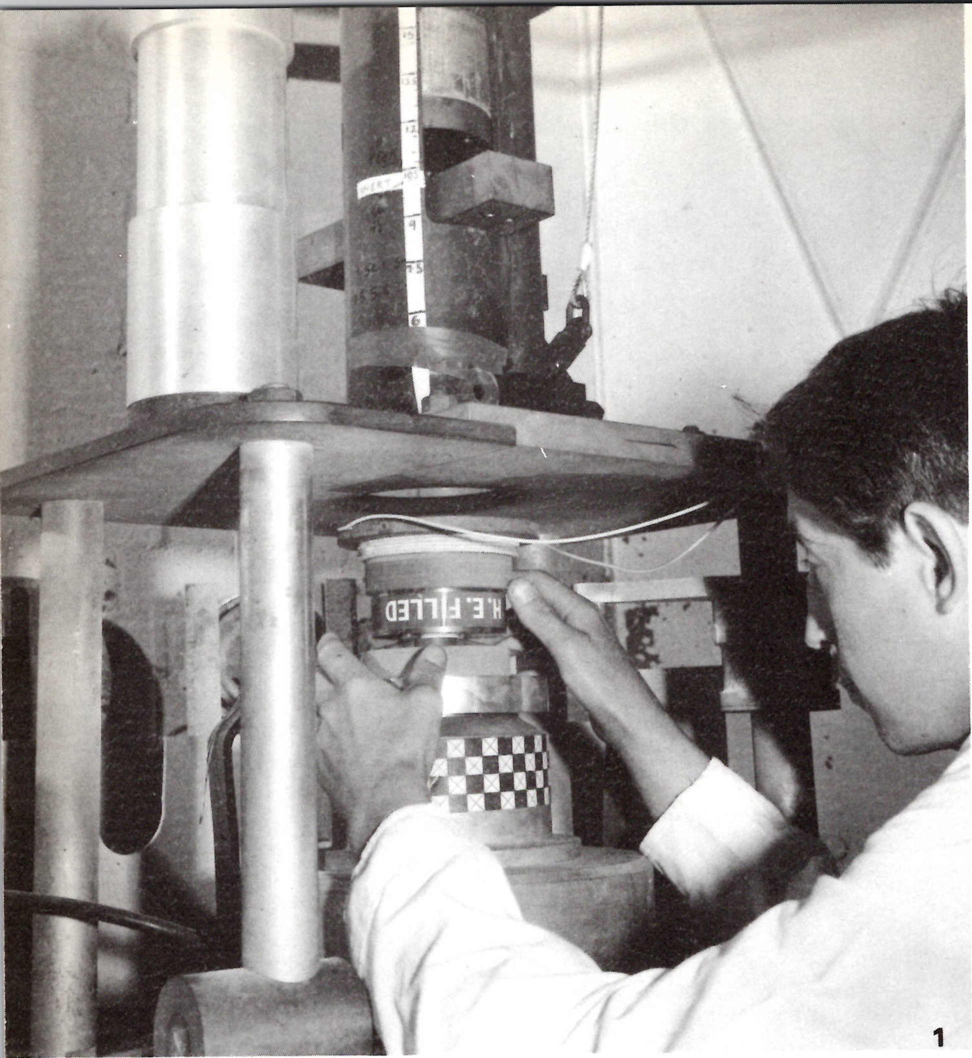
Explosives

Explosives Division is responsible for the development of high explosive compositions, detonators and other explosive components for nuclear weapons. The work requires diverse scientific techniques, mainly in the



1 Spray dryer for powder preparation
2 Surface analysis by Esca and Auger spectrometry
3 Separation of biological material by net mobility differences in an electric field

1 Assessment of explosive hazard with high-explosive charges subjected to thermal and mechanical stimuli
2 Weaving of 3-D reinforcement for composite material
3 Commercial floor-cleaner modified to deal with radioactive contamination
4 Specimen assembly for gas gun test
5 Setting up experimental firing of an initiator device
6 Checking oil temperature in isostatic press



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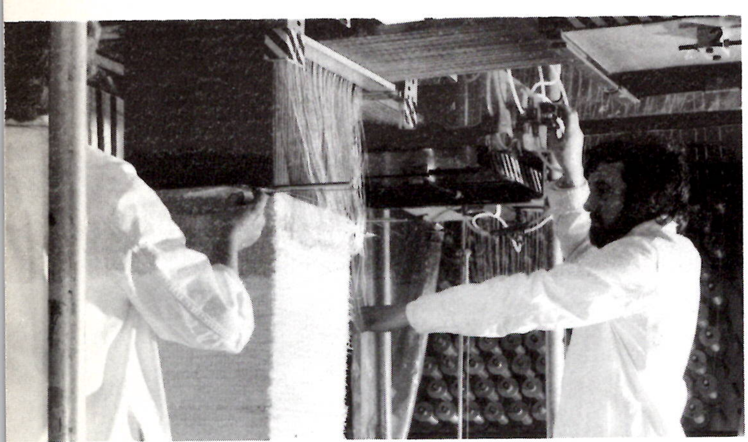

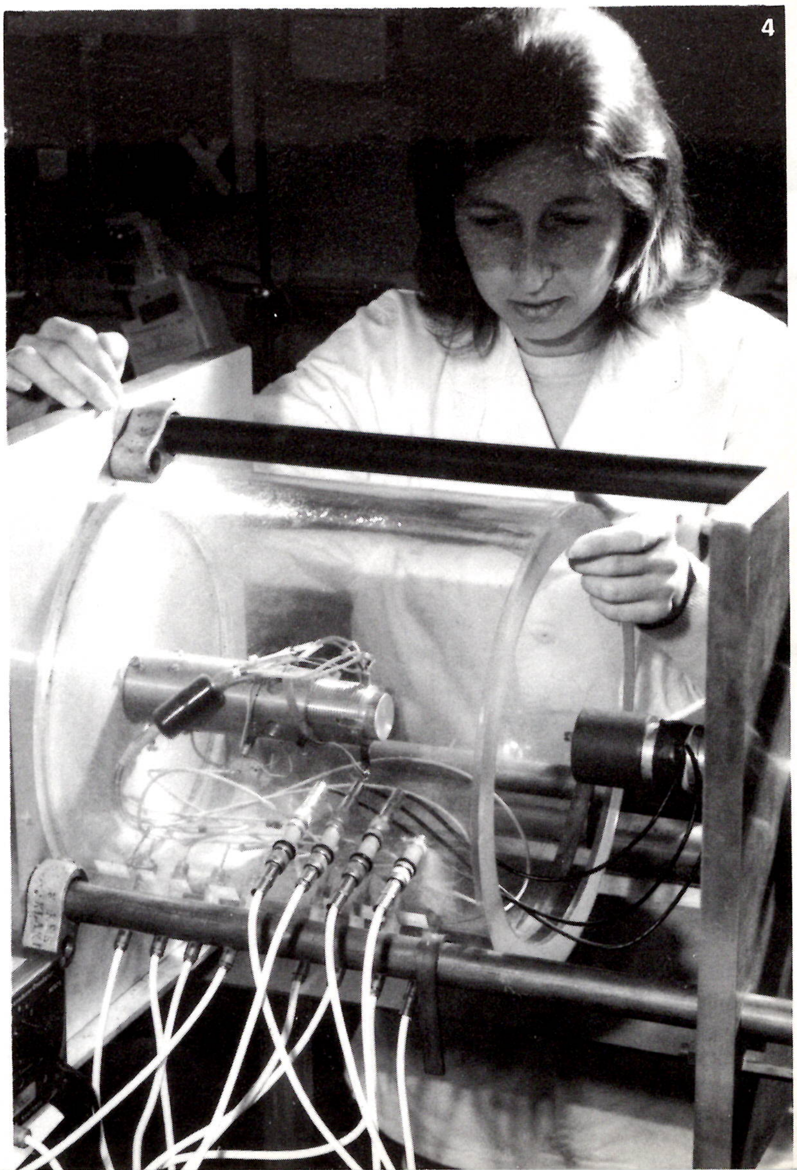

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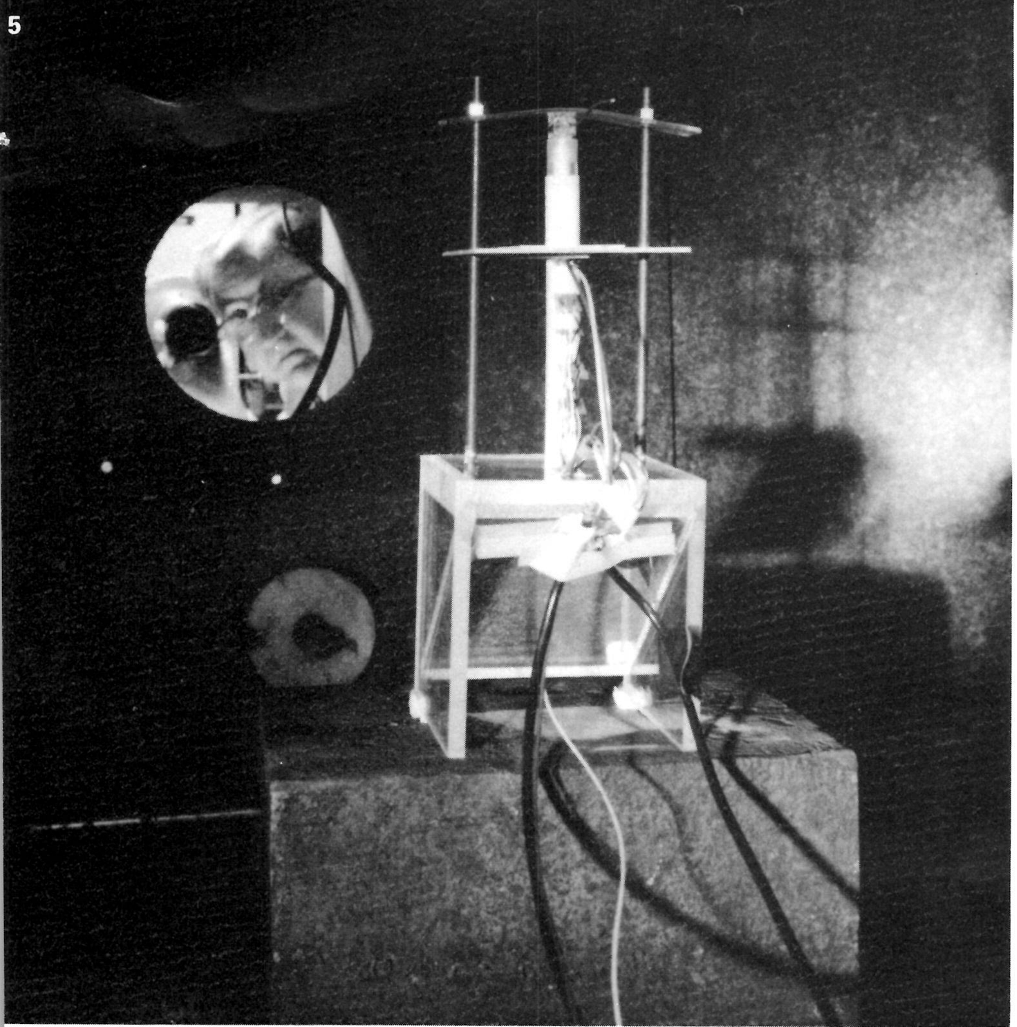

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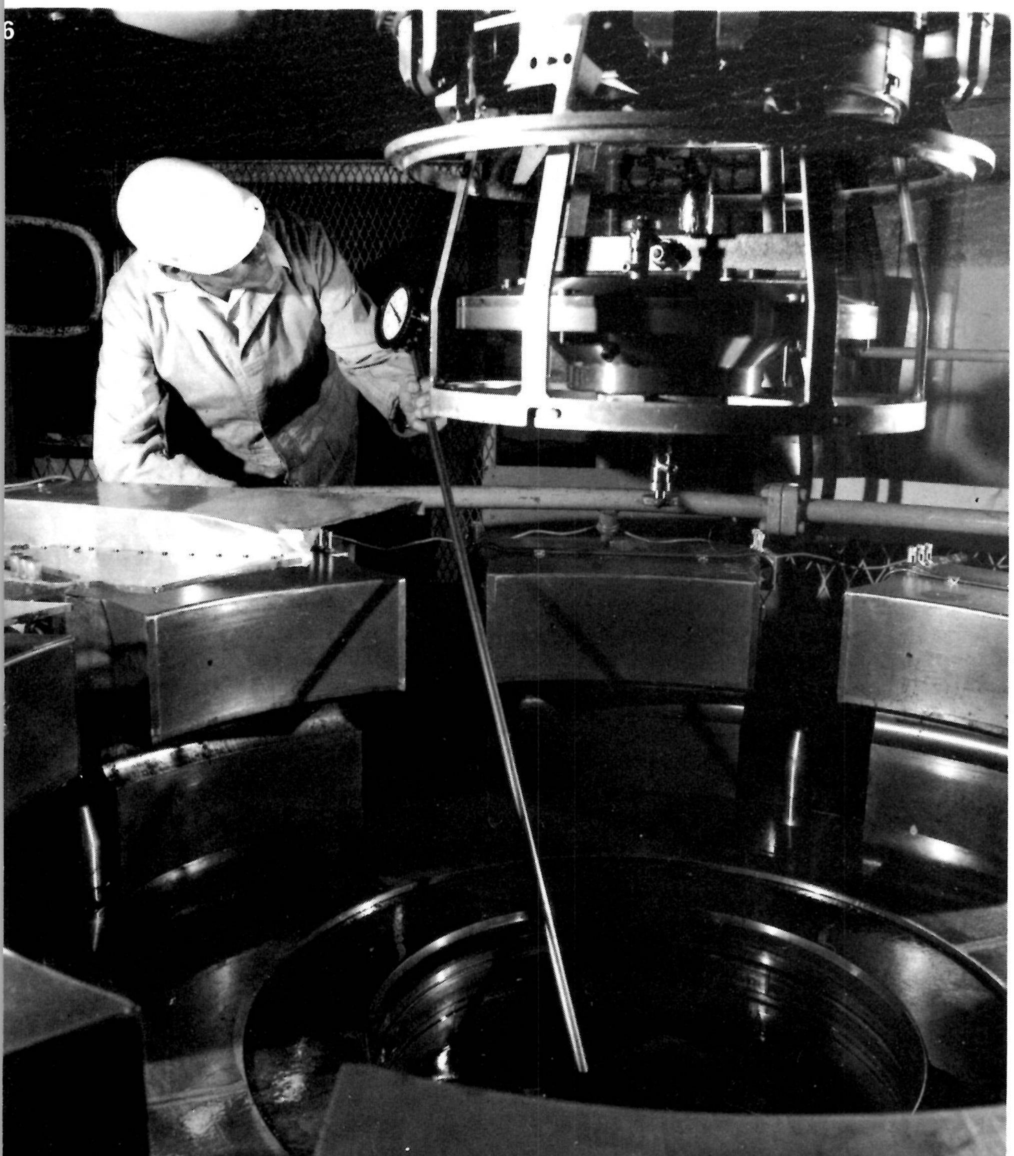


fields of chemistry, physics, mathematics and chemical engineering.

Electrically initiated explosive devices (detonators, actuators, squibs, etc.) are needed for functions such as initiating high explosive charges, moving small metal components or igniting propellant charges. Research on the functioning of these devices and the development of novel designs is carried out. This work involves the production and testing of finely divided explosive powders and the engineering of bodies for the devices. Devices are tested on their own and also in association with the appropriate receptor components to ensure that satisfactory initiation is achieved. Work is performed in a range of specially designed firing chambers, equipped with high and low voltage firing units, with electronic equipment capable of recording phenomena in the sub-microsecond range and high-speed streak and framing cameras, the latter capable of recording events at rates of 10^6 to 10^7 frames per second.

A variety of high explosive compositions is needed for various applications. Explosive power, sensitivity, safety uniformity and reproducibility are important characteristics. Development usually starts with small-scale experiments and the quantities used are increased, eventually to tens of kilograms, as information on the properties of the composition, particularly the safety properties, is accumulated. Explosive compositions consist of an energetic component (usually RDX or HMX) and a binder. Explosive powders of suitable particle sizes are prepared, if required, by comminuting the original materials obtained from Royal Ordnance factories or industry, using colloid mills or fluid energy mills. The particle characteristics of the explosive powders (size, shape, particle size distribution, etc.) and the physical properties of the binders are studied because they influence the rheology of the mixing process and the physical properties of the charges. The ingredients are combined in mixing vessels using slurry or paste mixing processes to produce moulding powders which are then compacted to form charges using platens or, more usually, isostatic presses.

The initiation and detonation characteristics of high explosive charges: shock sensitivity, build-up and detonation velocity, when initiated by typical detonator and booster components, are studied using the firing chambers and recording equipment described earlier. Safety is assessed using a range of tests, developed at AWRE and else-

where, which simulate likely hazards at different stages of the manufacture and Service use of the explosive. Test samples range from a few milligrams of explosive powder to pieces of several kilograms weight representing charges or sections of weapons. The hazards associated with accidental fires are assessed using various ignition tests, including a large-scale standard fuel fire and also using mathematical modelling techniques. Various physical properties: tensile and compressive strengths, moduli and strains at failure, creep and thermal properties are measured routinely, since they are important in determining the behaviour of the explosive in Service and also since they influence its safety properties. Climatic testing chambers are used to subject units to the temperature and humidity conditions encountered in Service.

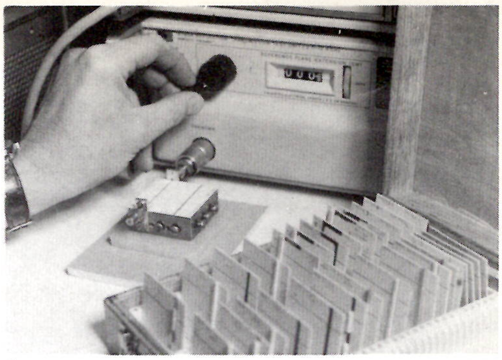
Accurate machining of complex explosive components is carried out using a range of advanced high explosive machining facilities, including a numerically controlled mill.

Metallurgy

The Metallurgy Division specialises in metals such as plutonium, beryllium and uranium, while having continuous research interests in the use of metals such as steels, tantalum, titanium, and other non-ferrous alloys. Most of the work is in the developmental processes of fabrication, such as vacuum casting, forging, rolling, deep drawing, spinning and vacuum consolidation of powders using cold and iso pressing technology. Joining processes play a large part — electron beam welding, pressure and diffusion bonding, vacuum brazing as well as lesser-used techniques of plasma spraying and sintering. Corrosion science is also important, together with the study of the compatibility of metals and alloys with other metals, liquids and gases: electroplating and chemical plating technology are used as adjuncts to the compatibility work, or in its own right, as in the plating of mirrors for potential use in space.

Other research includes the effect of impurity dissemination and grain size on the mechanical and physical properties of metals such as beryllium, the types of surface coatings resulting from various treatments and the effect of various inhibitors on metal/gas phase reactions. A comprehensive collection of electron X-ray diagnostic tools including the Steroscan, electron-probe microanalyser, and Quantimet equipment is available, together with sophisticated mechanical test equipment. Virtually all the equipment needed to conduct the pure and applied research studies is available within AWRE and is backed by modern and comprehensive machining facilities.

Work of a non-nuclear nature is also conducted for various Government Departments. A reputation for materials studies in thick film microelectronics technology has been established. Other work involves research into medical implants and armour-piercing devices.



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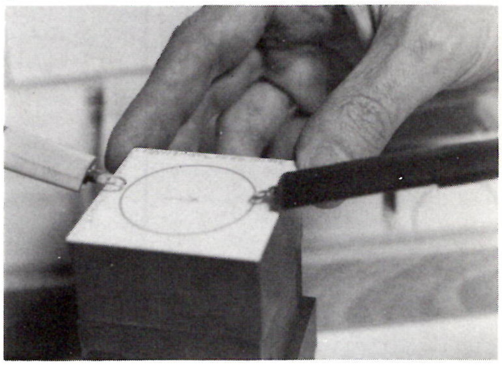

1 Test equipment for printed circuits
2 Machining facility for radioactive materials
3 Tensile test rig

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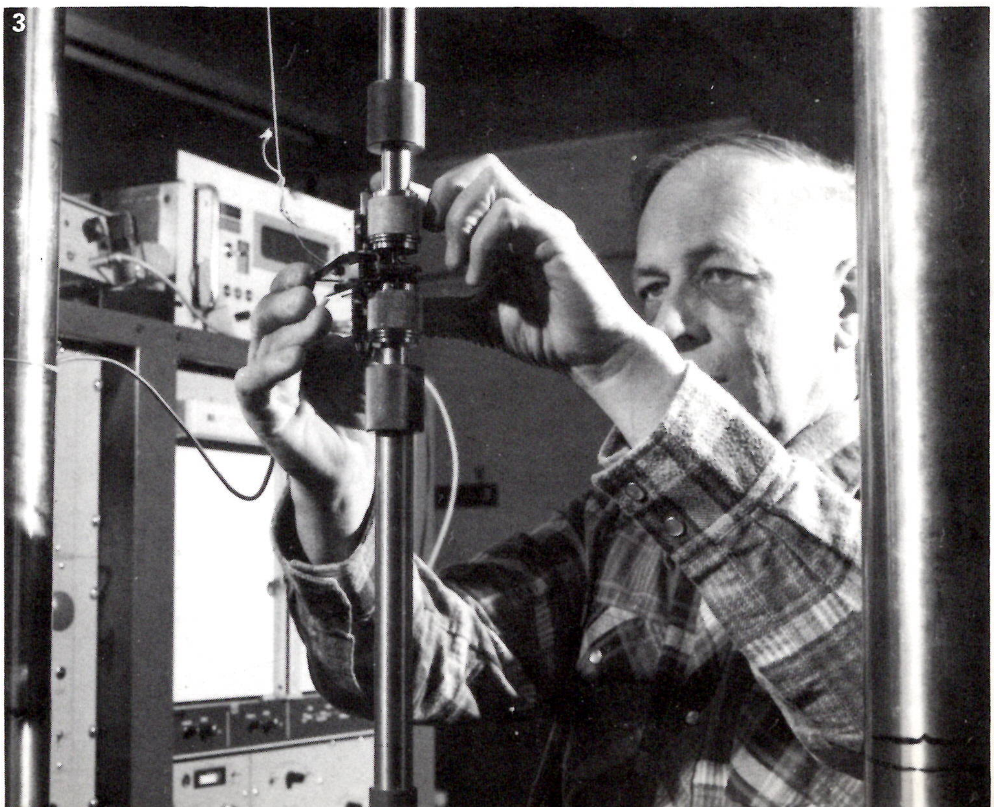

ENGINEERING

Maintenance in active area

Engineering Services include the design and construction of new plant and buildings, all maintenance work, engineering operations (and the operation of a Power Station), mechanical and electronic workshops, machine tool and metrology services and engineering support for Scientific Divisions. There is a Buildings and Maintenance Division, Engineering Workshops Group and Quality Assurance Group.

1 Template measuring machine using laser beam, designed and developed by AWRE
2 Cordax metrology test machine
3 Examples of complex work produced by numerically-controlled machine tools
4 Free-form measuring machine with air bearings
5 Apprentice under instruction on milling machine

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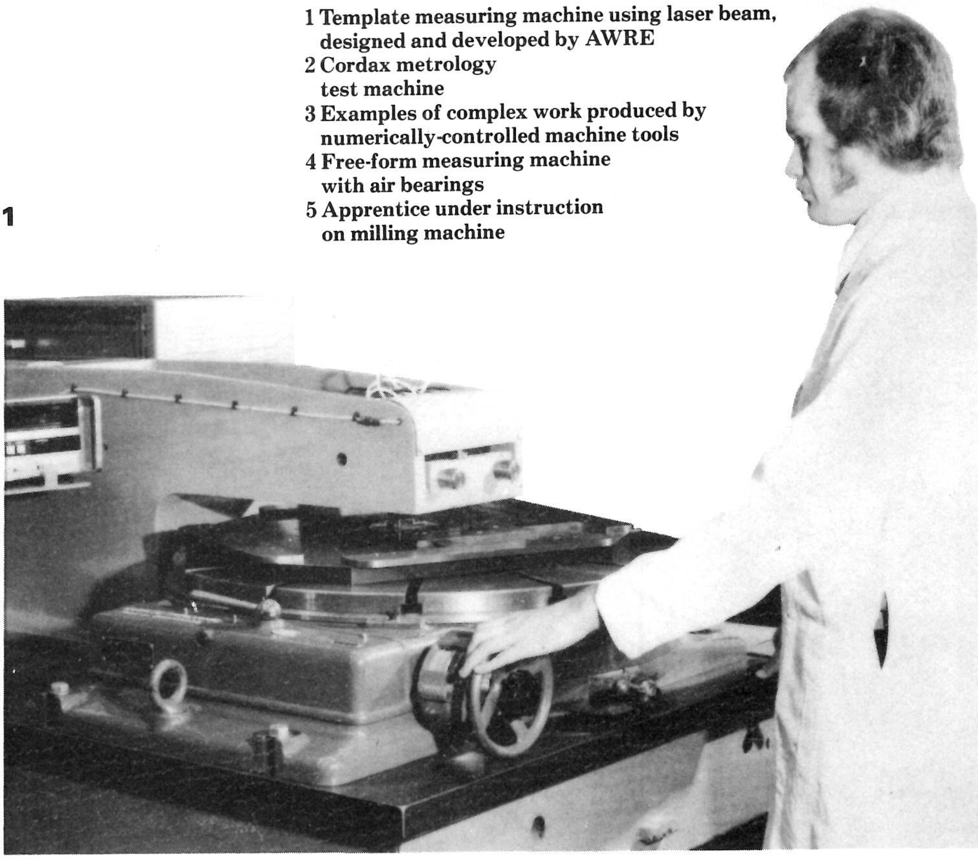

Buildings and Maintenance

This Division provides an integrated engineering service for the whole Establishment including the maintenance of specialised and, in some instances, unique plant and equipment. Its engineering staff includes professional engineers in the civil, mechanical and electrical disciplines, supported by skilled craftsmen and semi-skilled industrial workers and augmented by consultants and contractors.

Materials required for the nuclear programme are fabricated and machined under special conditions requiring the development of novel techniques. Moreover a whole range of project, design, operations and maintenance tasks need to be performed in exacting safety conditions.

Engineering Workshops

This Group, staffed by professional and industrial grades, is virtually a self-contained manufacturing unit, its capabilities ranging from precision engineering manufacturing to electronics assembly, development and testing. There are five main sections or areas of activity.

Manufacturing Workshops These engage in precision and general engineering production to meet the Establishment's manufacturing and research and development requirements. A range of trade skills are employed including instrument making, turning, milling, fitting, grinding, sheet-metal working, welding, etc., backed up with versatile machine tools and equipment. Numerically controlled machine tools and high-precision copying machines increase capacity for the manufacture of complex components.

Machine Tool Services The procurement, installation, maintenance and overhaul of the Establishment's machine tools is the responsibility of this Section. It covers all types of machines and control systems including sophisticated numerically controlled systems. A specialist machine tool staff gives an advice and guidance service to all Departments and there is a programme of design, development and construction of special purpose precision machine tools and equipment in support of the Establishment's manufacturing programme and development tasks.

Instrument Services This Section is responsible for electronics support for a complex environmental test facility involving systems development, instrumentation and specification preparation and testing. A service is provided for the purchase and maintenance of electronic instruments and test equipment for site use and for advice and guidance on the suitability of equipment. Additionally, development work is undertaken on a variety of projects, including specialist communications and control systems. The Section also has a specialist plastics group capable of undertaking development and prototype work. It provides further advice and guidance on plastics technology and in the use and application of modern plastics materials.

Engineering Techniques and Work Study A small Section of professional engineers and technicians provides the facility for engineering studies in manufacturing techniques and processes, and the management of other technical projects.

Apprentice Training There is an Apprentice Training School for first and second year training of Craft Apprentices undertaking a four year apprenticeship. Some 150 boys are normally under training in a wide range of trade disciplines. Additionally, practical training and projects are provided for Graduate and Student Engineering training.

Quality Assurance

A senior professional engineer is responsible for quality assurance activities throughout AWRE. He has a team of professional and technology grades of mechanical, electrical and metallurgical disciplines deployed as complementary teams of Quality Assurance Engineers and Control Inspectors in all working areas. They are supported by a Central Planning and Record Office and five laboratories. The latter are concerned with high-precision experimental measurements of dimensional, metallurgical and physical properties of engineering components. They maintain master reference measurement standards and are responsible for the development of special purpose quality control equipment required for metrology, electronic and non-destructive testing purposes arising from inspection areas.

Unorthodox problems are encountered through the extreme integrity required in nuclear work and involve sophisticated techniques in active, toxic and explosive environments, often calling for remote and automated handling. Commercial standards and practices need to be considerably refined or original techniques developed for the Establishment. Collaboration with scientific, project design engineering staffs and manufacturing centres is maintained to assure appropriate quality standards.

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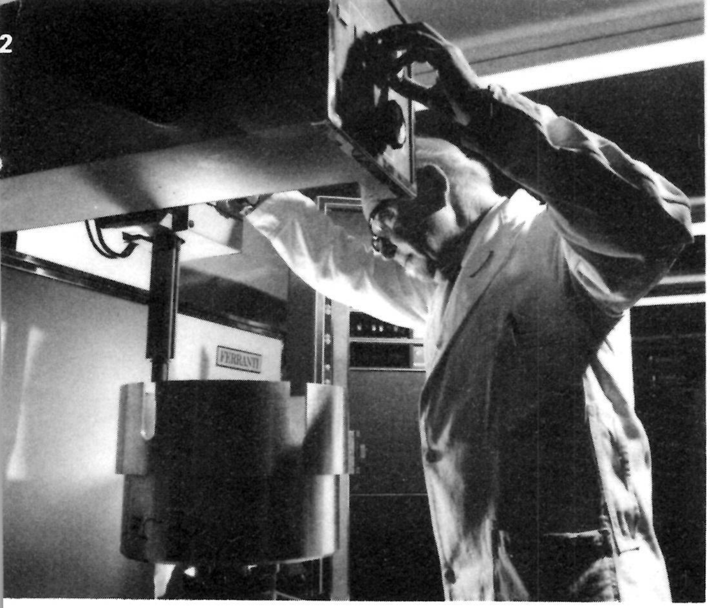

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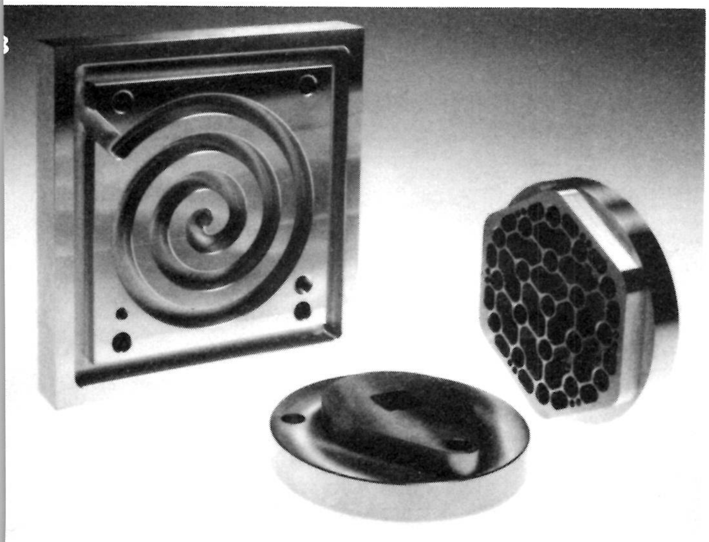

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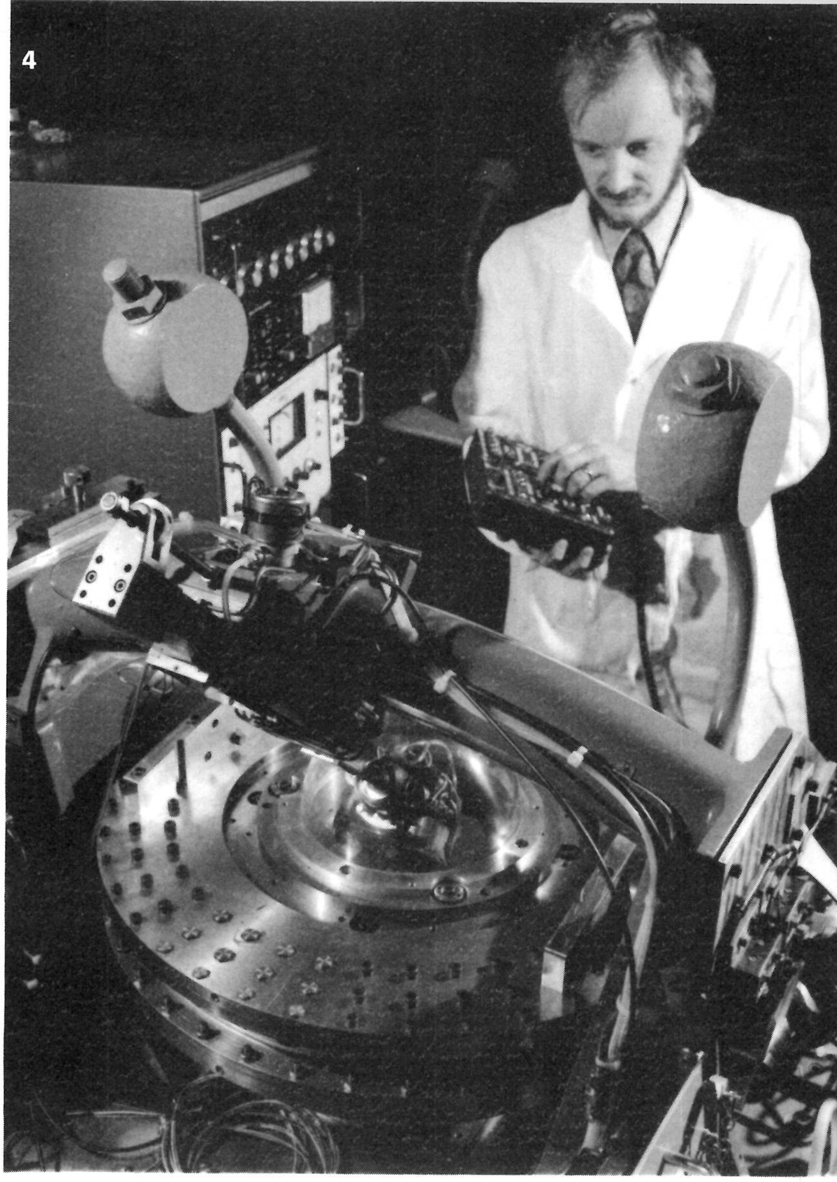

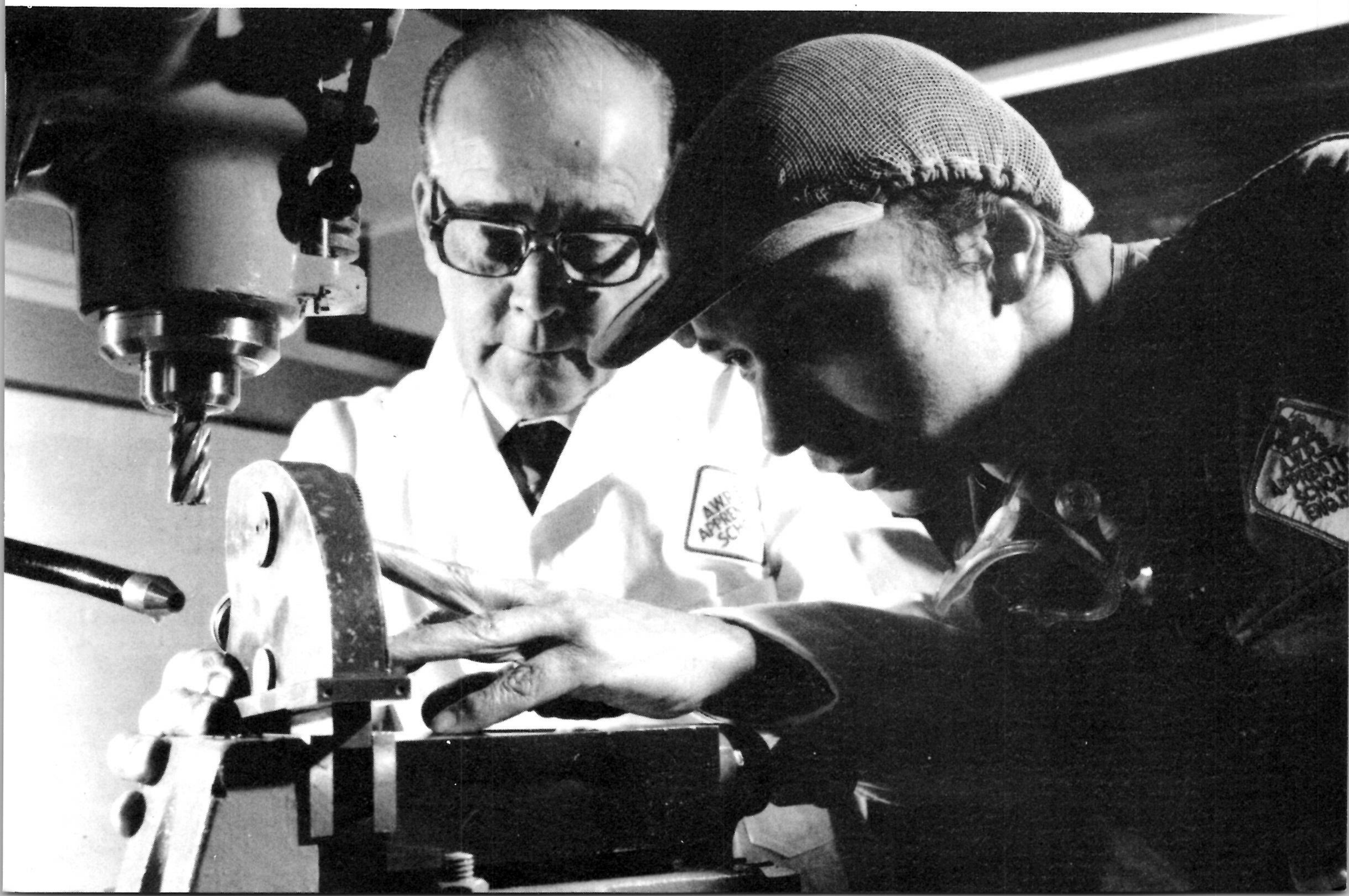

FOULNESS

AWRE's 'satellite' establishment on Foulness Island occupies an extensive area of fenland where wildlife also enjoys the protection of a secure perimeter. The external appearance of Foulness belies its key importance to AWRE in many important projects, particularly in: the effect and measurement of explosive processes, the study of shock and blast wave propagation, and the effects of intensive shock on materials and structures.

It is a self-contained national centre for these purposes and is licensed to fire the heaviest charges permitted in the United Kingdom. In this sense its isolation is an advantage but modern testing techniques have, paradoxically, made it a comparatively restrained neighbour of the more longstanding firing range at Shoeburyness.

Originally Foulness was concerned with the study of explosives and their effect in connection with the development of nuclear weapons. Since the major powers ceased to test atomic weapons in the atmosphere, it has pioneered methods of simulating and measuring the effects of large explosions on a reduced scale. The pressures and loads are simulated by using modest size explosive charges in conjunction with locally-made scale-model targets the models frequently being quite elaborate constructions in metal and reinforced concrete. The noise effect is often less than the explosion of a low-calibre

1 Air blast tunnel — antenna being set up for test
2 Air blast tunnel — exterior view

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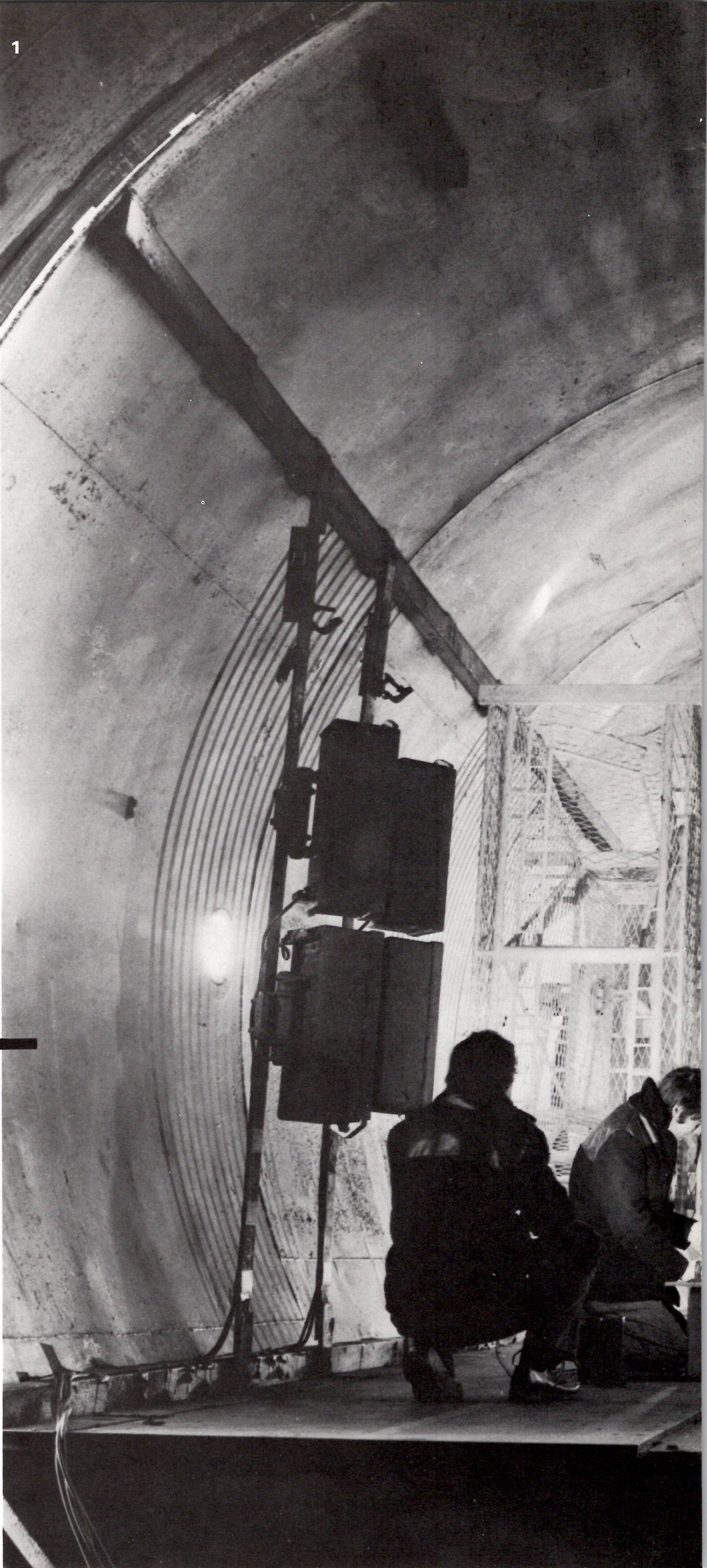

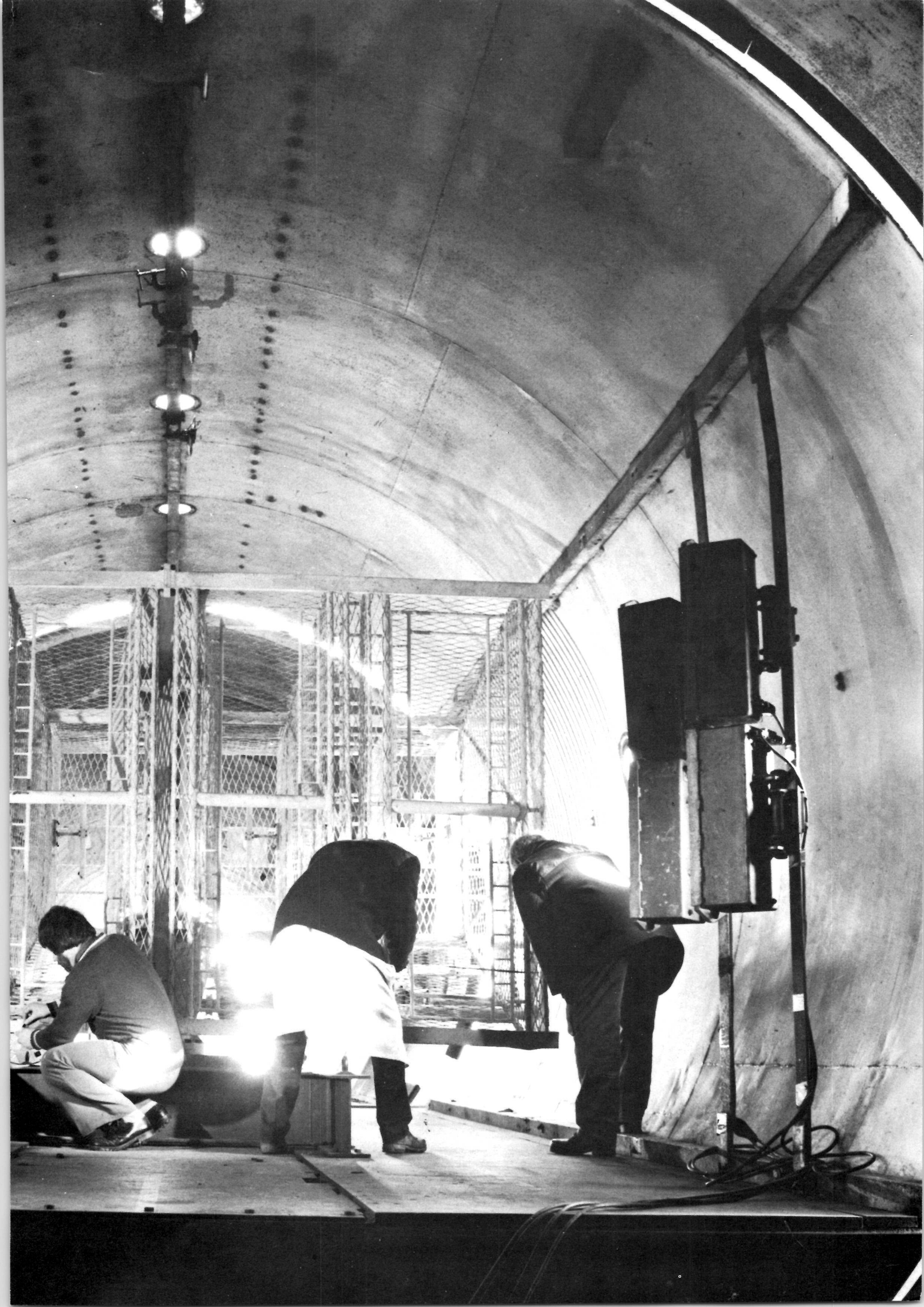

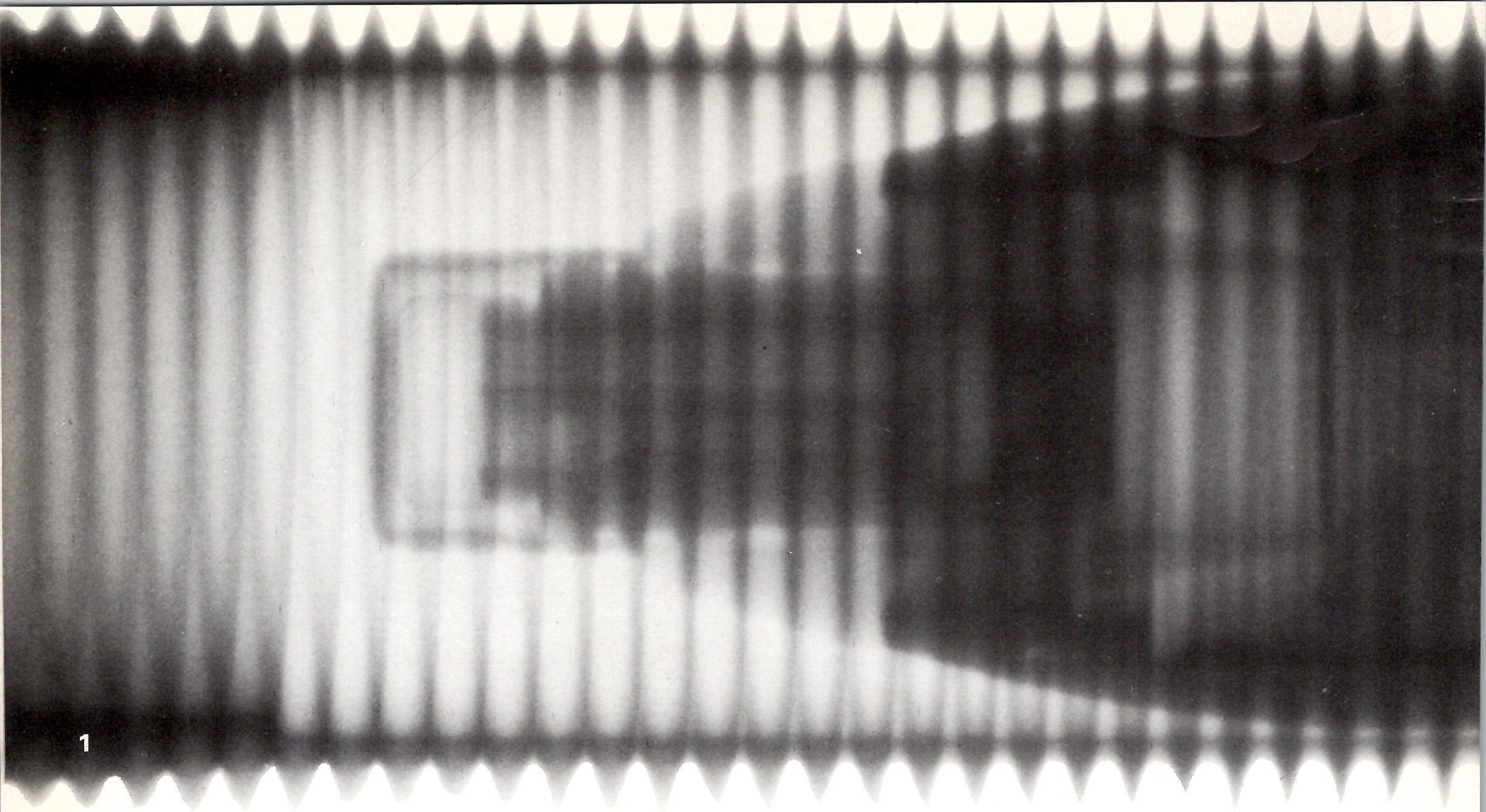

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1 Swarf radiograph of a mortar shell in its firing tube
2 General view of flash X-ray facility
3 Schematic plan
4 Swarf radiograph of detonating flat-ended projectile showing rupturing case

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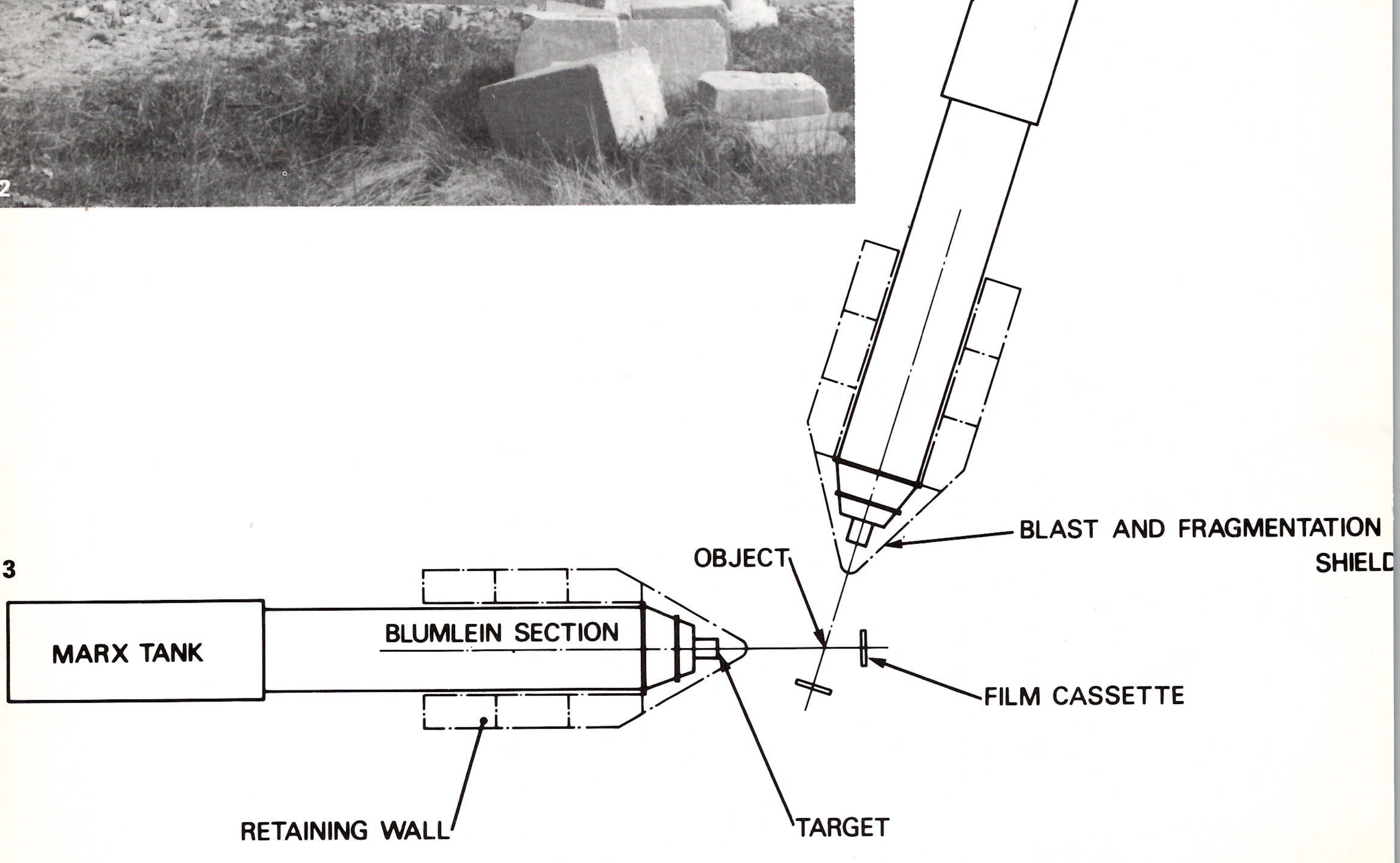

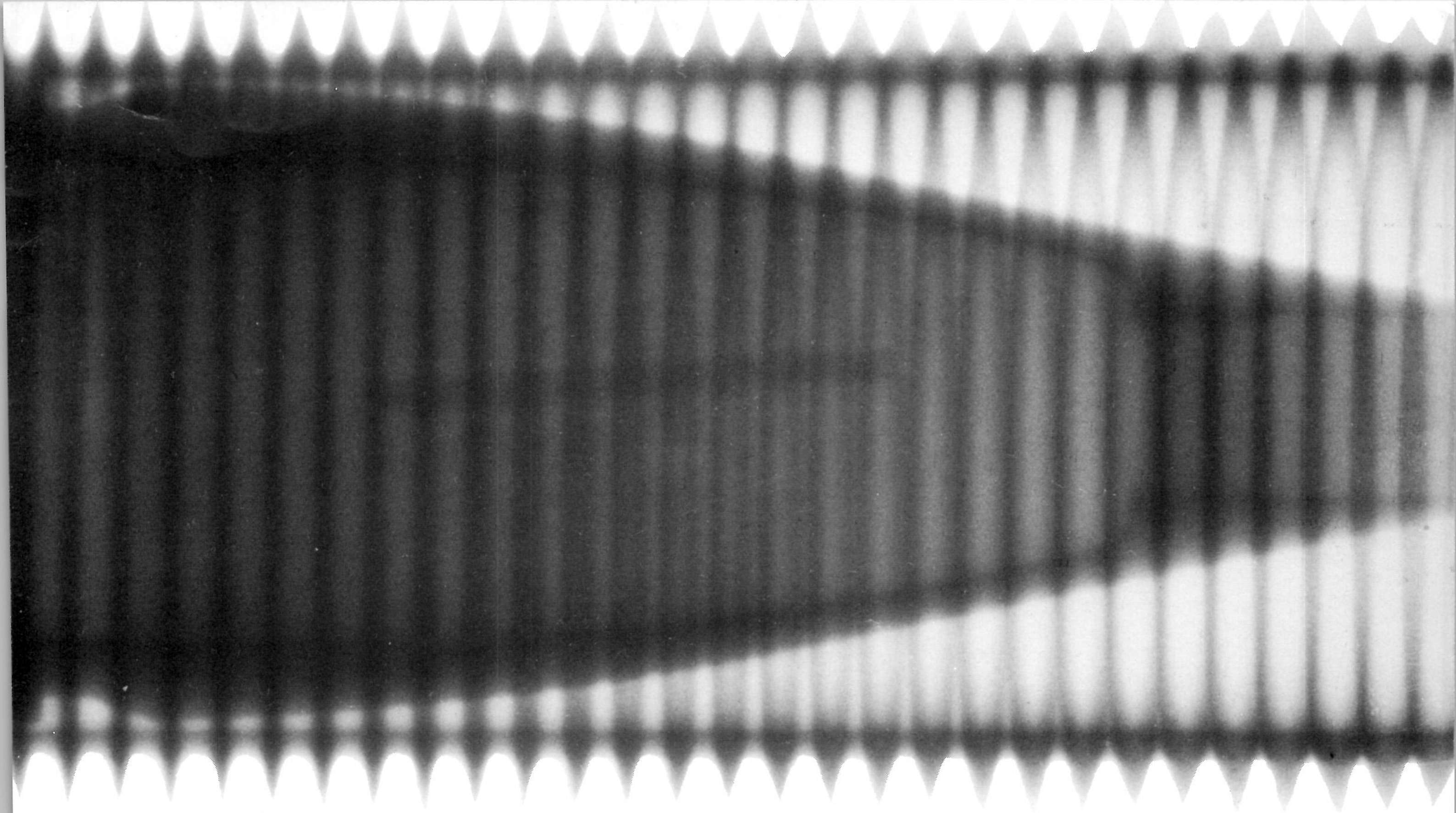

high-explosive shell. Explosive effects are studied from various angles by means of high speed photography, on milli-second time scales and by other advanced scientific methods.

Many of the Station's facilities have been designed and developed within AWRE and represent a high level of scientific and technological achievement. One of the most impressive is an explosively driven air blast tunnel. It is virtually a shock tube, or cylindrical expansion tunnel, more than 500 feet long. Visually it is similar to a huge surface oil pipeline in three stepped sections of different diameter fitted in ascending order. The explosive charge, which is fired at the smaller end, is made from detonating fuse wound spirally around a polystyrene former to produce blast waveforms of specific peak pressure and duration. Large items of military equipment such as armoured vehicles, naval masthead radar antennae and other vulnerable equipments are exposed in the test section, the confining nature of the tunnel creating effects similar to those experienced in atomic explosions. The recording apparatus is housed in adjoining buildings, and in mobile trailers which can be moved up to the tunnel.

Co-operation as a consultant, has been maintained with the Italian Government in the building of an air blast simulator facility in Italy similar to that at AWRE Foulness.

Another facility of high achievement is a dual flash radiography system known as *Swarf*, the most powerful flash X-ray facility in the United Kingdom. It can record transient events such as the penetration of an explosive device into armour or other high-strength material through thicknesses up to an equivalent of 18cm of steel. Since the exposure time is nano-seconds, it can 'freeze' detonation phenomena and explosive jet propagation in pictures, from two different angles and sequenced in time at intervals of microseconds.

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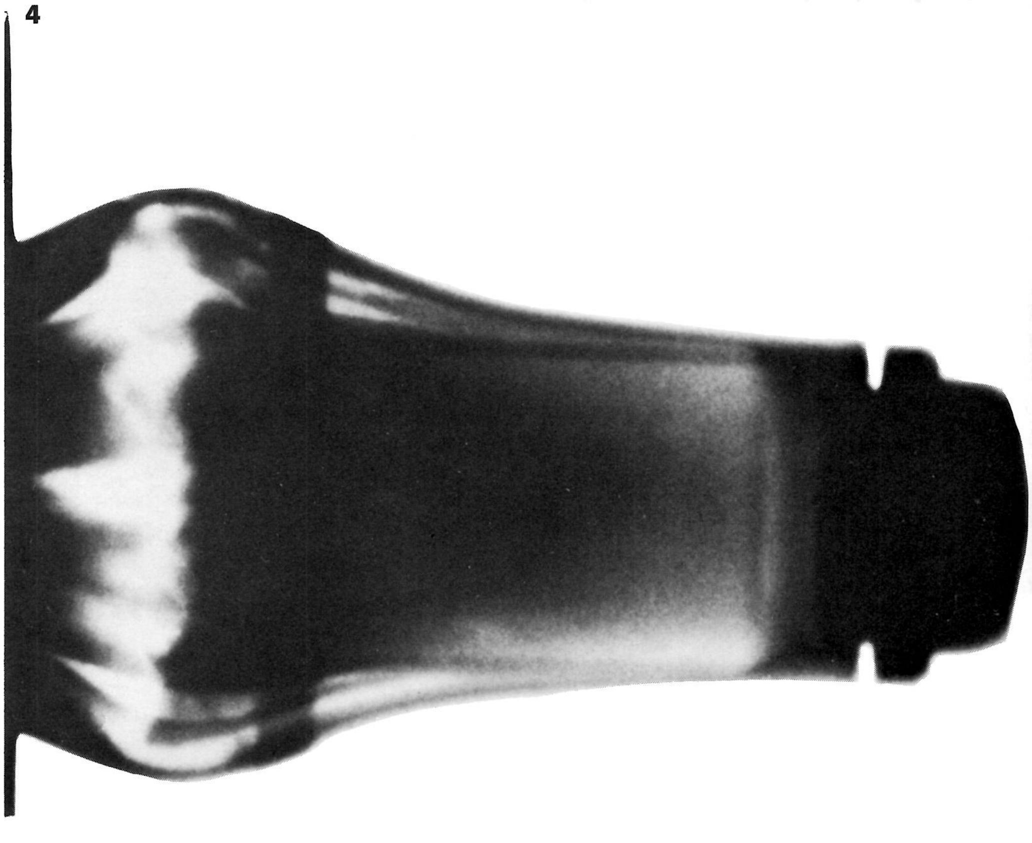


As pressure measurement is a large part of the Foulness task many other devices have been developed to

measure the effects of various pressures in solid, liquid and gaseous media. These include microphones, hydrophones, barographs, transducers for atmospheric and underwater purposes, piezo-electric devices, etc. The site accommodates the National Calibration Laboratory for the dynamic testing of pressure gauges.

The Station has a wide range of supporting technical and administrative facilities and a direct link with the Aldermaston computer services. It operates an Apprentice Training Scheme (some 15-18 students per year) similar to the one at AWRE Aldermaston. Socially and recreationally it is also a self-contained unit with yachting, flying and civil service clubs in the area and the advantage for employees and their families of residing within reach of several East coast holiday resorts.

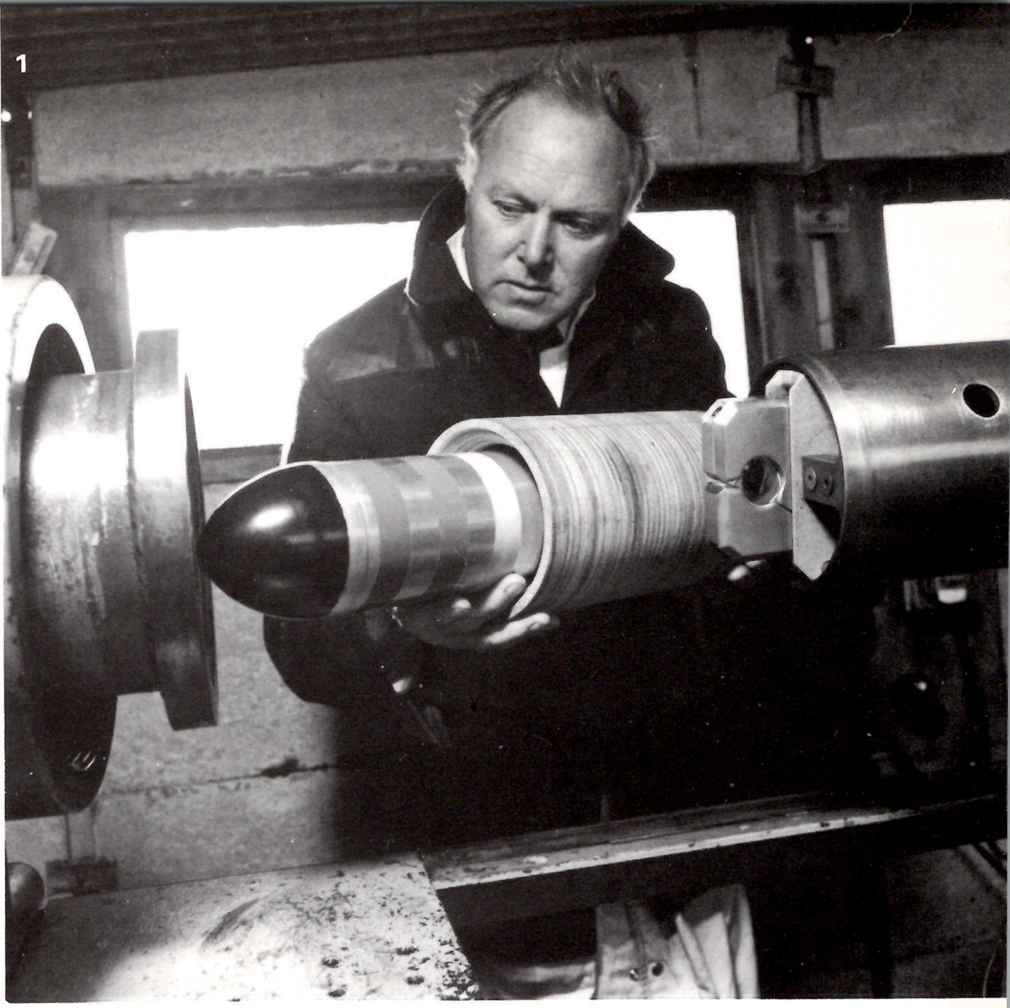
During the past few decades the expertise developed at Foulness, like that at Aldermaston, has found many outlets which benefit industrial and governmental authorities. These include investigations into disaster hazards, such as the sudden failure of pressure vessels, the structural integrity of gas, chemical and oil storage plants and pipelines and surveys of damage and pressure experienced in disasters with the consequences of those at Flixborough and Ronan Point.

Much of this work is performed on behalf of the United Kingdom Atomic Energy Authority. Until recently most of the experimental work on the safety of reactor structures was conducted at Foulness. There is direct help to industry and, through European atomic energy authorities, such as Euratom, with its headquarters in Brussels, to several continental countries.

Foulness has constantly expanded its range of research projects and can offer industry, both in the civil and military fields, unrivalled facilities for testing materials and structures likely to be exposed to hazardous explosive conditions, by accident or design. Where possible the availability of its special expertise is extended for long-term on-site research programmes, with facilities for originators to witness important tests.

A development in the near future will be the merger of AWRE, Foulness with RARDE, Potton Island, Foulness will remain an outstation of AWRE but will undertake field services for RARDE.

Further information will be provided on application to AWRE, Foulness.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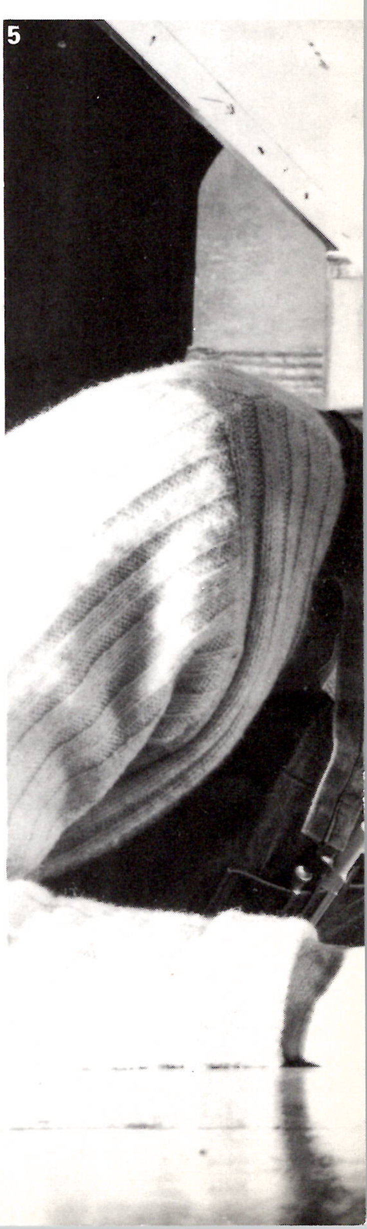
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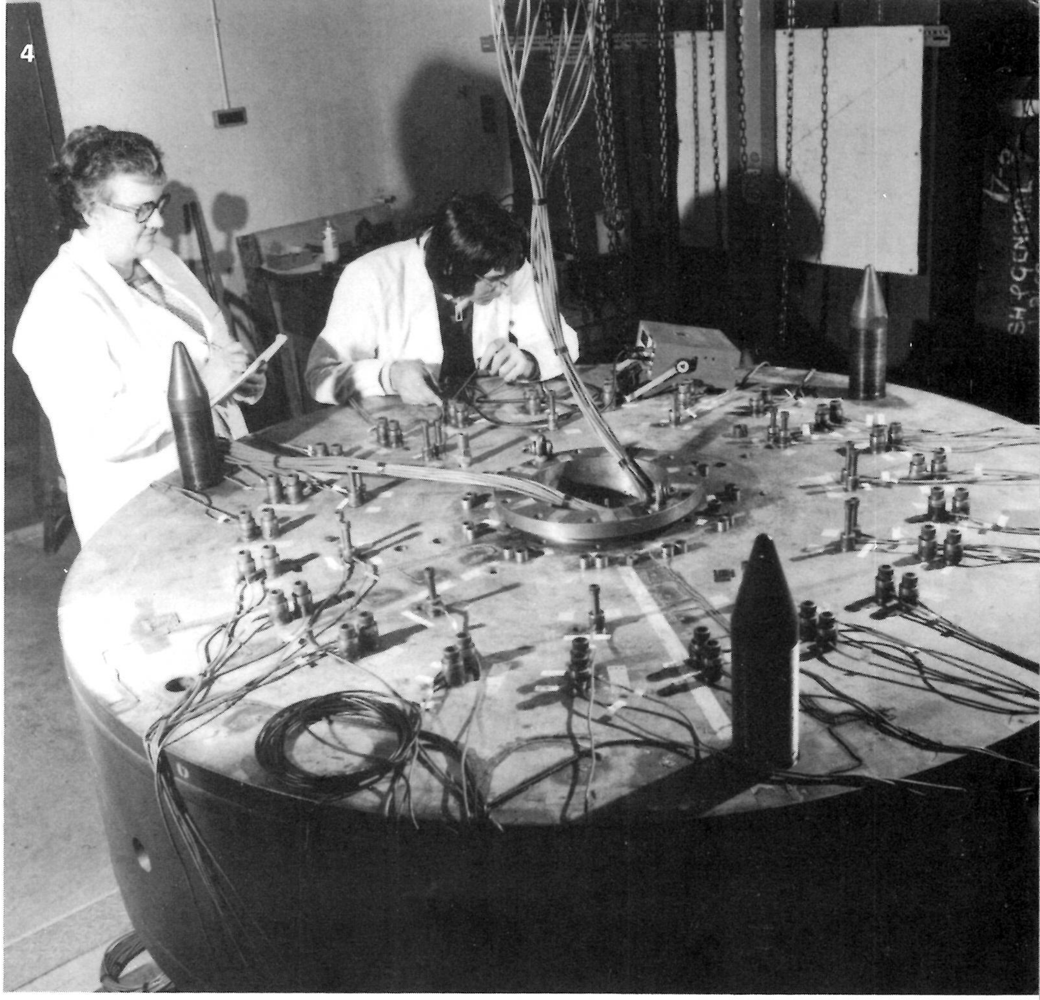
1 Deformable projectile simulating aircraft impact being loaded into compressed-air launcher
2 Rear face of reinforced concrete target for aircraft impact tests
3 Control room for remote machining of explosives
4 Scale model of fast reactor instrumented for reactor safety experiments
5 Mounting model hovercraft in the 18in by 30in shock tube



A safety, monitoring and advisory service is an integral part of the Establishment. A team of professional health physicists, scientists and engineers assess the safety of new plants and procedures, check the conformity of existing equipment and practices with statutory requirements, and supervise the radiological and general safety services. These activities demand experience of a wide range of technologies, including toxic material processing, nuclear criticality, explosives, chemical plant, lasers and high voltage electrical equipment. The practical health physics tasks are: radiation and contamination survey in radioactive laboratories and workshops, personnel dosimetry, bio-assay and environmental monitoring generally. Procurement of a whole-body monitor is now in hand for the purpose of screening, on a regular basis, staff working with radioactive materiasls. The Division is also responsible for scientific assistance to other Government Departments and the Armed Services on matters relating to radiological defence and the operational safety of nuclear weapons systems. In support of these roles a multidisciplinary research and development effort is maintained to deal with problems arising in nuclear security, radiological protection and industrial hygiene.

The study of the modes of formation and properties of toxic aerosols is a research activity which is relevant to the safety of radioactive processing plant and nuclear reactors. Special laboratory facilities and novel techniques of aerosol production (eg exploding wires) are employed to simulate a variety of accident conditions. It is important to determine the quantity and form of aerosol which might be released, particularly the potentially respirable fraction. An Aerosol Section also develops methods of assessing the possible consequences of an atmospheric dispersion of toxic material in particulate form, in terms of environmental contamination and potential hazard to man. Computer models are used to predict the outcome of a wide range of hypothetical events, such as an accidental leakage, a fire involving radioactive material or a nuclear explosion.

There is a continuing need to improve methods of identification and measurement of non-radioactive aerosols which might be hazardous or merely a nuisance. New techniques, mainly microscopic, for examining fibrous dusts (eg asbestos) and dusts formed in the use of new composite materials — are being assessed and updated. A dust monitoring service is provided.

Methods of measuring nuclear radiations are continually being developed and applied to radiological protection and radioactive processes, for example, in nuclear material accounting and the inspection of materials and components by radiation gauging and radiography. Various techniques cater for a wide range of intensities, from the low levels encountered in natural and working environments, to the flash situations created by laboratory and field experiments. Military dosimeters and dose-rate instruments are designed, developed, tested and calibrated. Project management is provided in respect of such equipment for the Services and support is given to Services representatives at international meetings on radiological defence matters.

A special electronics branch is responsible for the provision and maintenance of a variety of nuclear instruments for AWRE. This instrumentation is required for radiological protection, weapon accident monitoring, laboratory measurements, intelligence, security and waste control. The equipment ranges from the elementary to the sophisticated — from

HEALTH AND SAFETY

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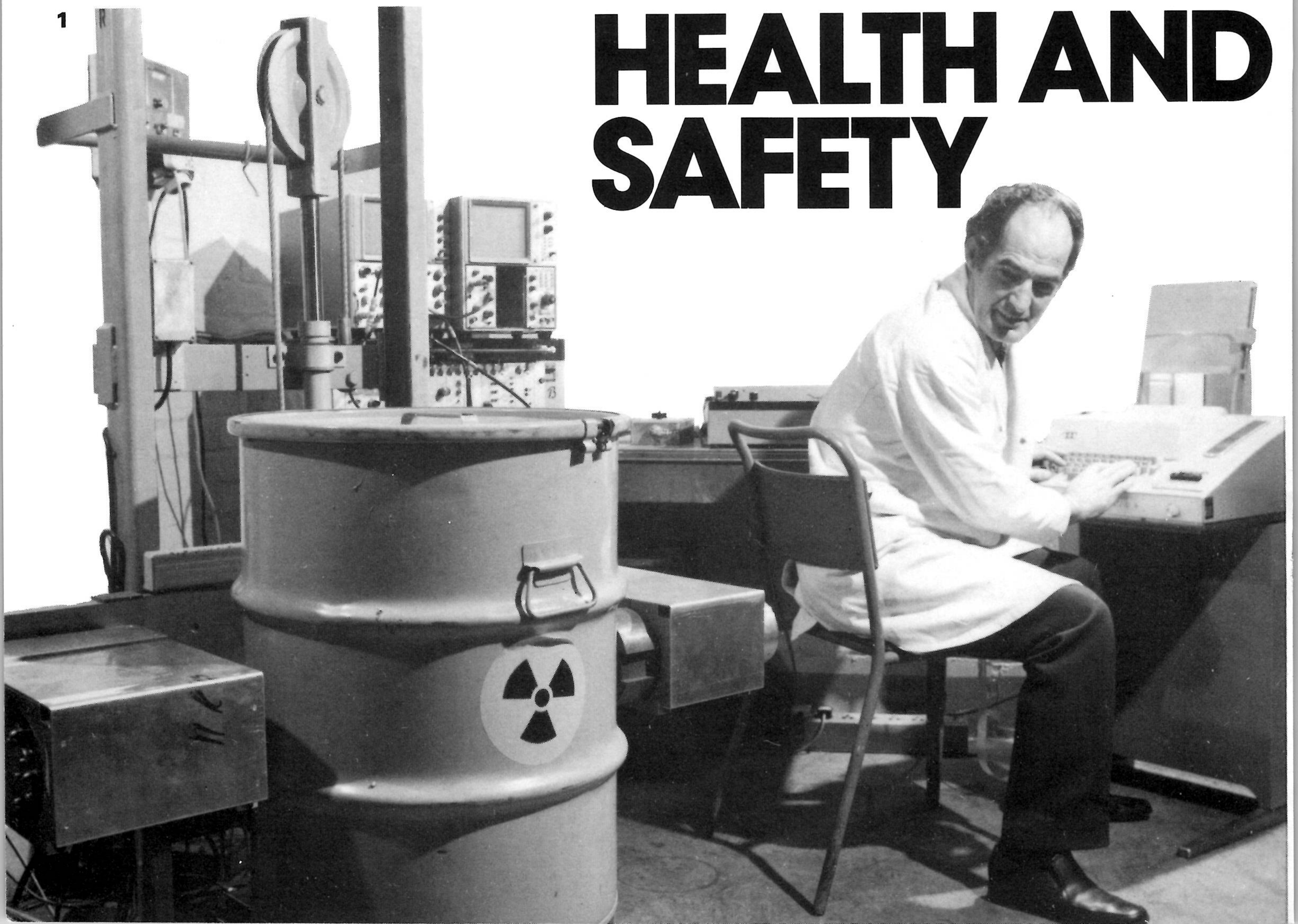

1 Scanner for checking shielding in waste drums
2 Film badge monitoring equipment
3 Transportable radioactivity monitor for gases
4 Fireman's personal dosimeter (carried on belt)

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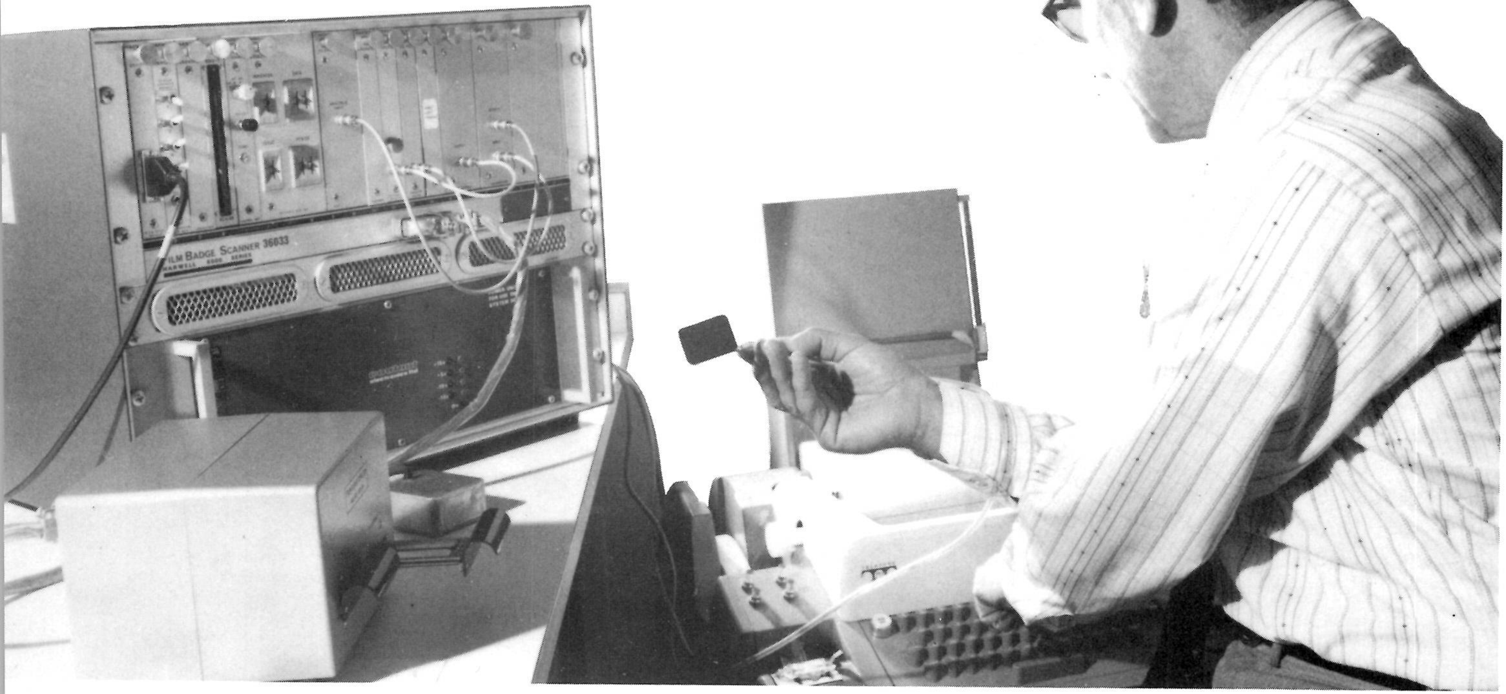

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the simple Geiger-counter radiation detector to complex computer-based high resolution semiconductor spectrometers that are used for X-ray fluorescence and gamma-ray isotopic analyses. Generally, the instruments and dosimeters are calibrated using a comprehensive range of X-ray and other irradiation facilities. A new versatile 10 MeV electron linac will cater for electronic component studies and for special radiographic examinations.

Medical

A full occupational health service is provided staffed by medical officers, nursing staff and supported by a pathological laboratory and X-ray department. the service provides toxicological advice to Divisions as well as overseeing the health of employees and carrying out epidemiological research.

ADMINISTRATION

The Secretary's Department is responsible for all administrative aspects of the work at Aldermaston and Foulness and participates in the overall management of the Establishment. It procures resources and ensures effective administrative collaboration between the Establishment and the Ministry of Defence. It has four Branches with the following roles:

Personnel To ensure the maintenance of the work force at approved numbers, grades and quality to perform the Establishment's tasks and to give help and guidance to individual workers to achieve career aspirations.

Accountancy To provide effective accountancy and financial control services; the procurement of stores and services within appropriate specifications and timescales; and the storage and issue of goods and materials.

Administrative To provide administrative support and some general site services. The principal services are secretarial, administrative support to Divisions and to security and safety services; general site services, such as Police, Fire Brigade and general transport and communications services; and amenity services including housing and hostel accommodation.

Technical Services To provide information and analysis of technical programmes and related resources for senior management, and to act as an interface between AWRE and appropriate Headquarters Groups and to maintain liaison with United States Agencies under the UK/US Defence Nuclear Exchange. Technical services also include photographic and reprographic facilities, advice on military and commercial classification and industrial property rights, and a library and information organisation.

A panorama of complex scientific knowledge is available through the library service which is based on a computer system. Its 'catalogue' is in microfilm form which is selected and presented according to need. Its computer stores published scientific and technical literature on magnetic tape and retrieves it with relevant references for individual users. The service also includes teletype links with information data bases in Britain, Europe and America.

General view of the library

RECREATION AND SOCIAL FACILITIES

Being situated within easy reach of Reading, Newbury and Basingstoke, Aldermaston offers an interesting choice of shopping facilities and social activity. Reading and Basingstoke both have modern traffic-free shopping precincts and Newbury is a busy market town with many countryside activities, including important associations with 'the turf.' To the North lie the Thames Valley and the Cotswolds and within about two hours by road are the New Forest and the South coast.

London is easily accessible from Reading via the M4, or by rail to Paddington — a train journey normally taking only 25 minutes. Alternatively, from Basingstoke the M3 also gives fast access to central London, or, by train, Waterloo is 45 minutes distant.

At Aldermaston there is a particularly active Recreational Society with an excellent club house and grounds adjoining the Establishment. The Club House facilities include a bar and cafeteria, a well-equipped theatre, squash and badminton courts, a gymnasium and a judo room. The Recreational Society also caters for such diverse interests as motoring, angling, yoga, golf, basketball and drama. The grounds nearby have pitches for Rugby, soccer, cricket and hockey, grass and shale tennis courts and a bowling green.

Residential accommodation

For those who seek residential property there is a wide selection on the open market but staff recruited from beyond the normal daily travel radius may be offered housing, owned by the Ministry of Defence, on modern housing estates on the outskirts of Reading, Basingstoke and Newbury and near the Establishment. Bus services between these residential areas and the Establishment are regularly available.

CAREER OPPORTUNITIES

Within its exceptionally broad field of scientific work AWRE offers many career opportunities.

For suitably qualified young people the scope is almost limitless. There are posts for inorganic and physical chemists, physicists, mathematicians, materials and polymer scientists, engineers and chemical engineers, technologists and plant managers. The work is of absorbing interest and intellectual satisfaction is to be found in all spheres.

AWRE encourages a diverse approach to projects and its policy leads to imaginative and novel solutions. There is ample scope for individual initiative. Members of staff are encouraged to develop their own ideas — to transform laboratory tested ideas into technological reality — and, depending on their particular talents and the nature of the project, they may either be asked to continue their own research or act as a member of a research team. To widen their experience and keep in touch with latest developments, members of staff are, in any event, expected to undertake a number of projects within a few years.

Those with organising and managerial aptitude also find broadening opportunities in charge of processes or plants, with responsibility for quality and cost control, forecasting, analysis and the direction of staff. The publication of research papers in open literature is encouraged and individuals are also given the opportunity to attend appropriate scientific conferences and specialist courses to keep abreast of new techniques and developments in their particular fields of interest. Contacts are maintained with universities, research associations and with industry, either informally or on a consultancy basis, or by extra-mural research contracts.

Scientific staff enter through the Scientific Group of the Civil Service which recruits for all government research establishments. Applications are invited from graduates and post-graduates, and some technically qualified non-graduates. In general, the work offers wider scientific experience and freedom for personal action than is normally to be found in industry; it also offers the chance to travel on duty within the United Kingdom and for specific duties overseas.

Those interested in the prospect of employment at AWRE may answer published advertisements for staff or write for further information to:

The Chief Personnel Officer
Building F6.1
Atomic Weapons Research Establishment
Aldermaston
Reading RG7 4PR

Initial information may be obtained from Ministry of Defence Careers Information Officers who visit most universities in the United Kingdom during Easter terms, often accompanied by representatives from AWRE. Those wishing to pursue the matter are then advised to complete and forward Civil Service Application Form No. S654.

Those for whom AWRE is likely to find suitable posts are invited to a selection interview, usually held during Easter vacations. When possible they are also allowed to visit laboratories to see work in progress, travelling expenses being reimbursed and, if necessary, overnight accommodation provided.

ORIGINS

Although AWRE was established in the early 1950's to meet the rapidly expanding needs of the nuclear weapons programme its origins date from the immediate postwar years.

The war had prevented Britain from pursuing nuclear research alone but by early 1947 British atomic energy policy had emerged as an urgent need for the production of fissile material, the fabrication and testing of an atomic device, and a subsidiary aim of exploring the possibilities of nuclear power to relieve fuel shortages.

The programme was considered essential for the nation's future and its execution was to become the responsibility of several government research and development establishments, some of which are now household names, such as Harwell in Berkshire, the home of atomic energy research, and Windscale in Cumbria, where the first nuclear piles and separation plant were built. Aldermaston was destined to become the defence link in the chain.

British scientists were first to recognise the feasibility of producing nuclear weapons but it was the American Manhattan Project which developed the atomic bombs dropped on Hiroshima and Nagasaki bringing the Second World War to an abrupt end.

When the government decided to develop its own bomb as proof of British capability for nuclear deterrence, Dr William Penney (who was later raised to the peerage) was a natural choice for this momentous task. He had been among a team of British scientists who had crossed the Atlantic in 1944 to continue their nuclear research in association with the American project. He had flown over Nagasaki when the second atomic bomb was dropped from an American aircraft and had subsequently visited Hiroshima to measure the effects of the first atomic explosion. He was also an observer at the American post-war atomic tests at Bikini Atoll in the summer of 1946.

Apart from his nuclear research, Dr Penney had been concerned with many scientific projects for the Armed Services, including the study of wave effects on the transportable Mulberry harbours used during the invasion of Europe and he had earned a high reputation within the government and among Services chiefs. Early in 1946 he had been appointed Chief Superintendent of Armaments Research and later that year spent some time as Scientific Adviser to the British Representative at the United Nations Atomic Energy Commission.

In the following year he made known to a select group of British

Lord Penney

scientists and engineers, the government decision to develop and test a nuclear device, which was to be similar to the bomb which devastated Nagasaki. He then set up a headquarters for the project at the Armament Research Establishment at Fort Halstead in Kent, within a special unit which, for security reasons, became known as 'HER' (High Explosives Research). He also decided to use other facilities at Woolwich Arsenal and at the military firing range at Shoeburyness in Essex, and in the following year another outstation was set up at Woolwich Common.

Although there was originally a limited and finite view of the task, 'HER' very quickly found itself with much wider, more complex and long term responsibilities. The Chiefs of Staff had stated their conviction that the best method of defence against atomic bombs was likely to be the deterrent effect of retaliation. When they announced their requirement for deterrent weapons the relentless momentum of the work had created a need to centralise most of it, particularly because of its peculiar hazards and the need for exceptionally strict security. A new site was needed to encompass research, production, assembly, gauging, storage and other important functions; with responsibility for testing weapon components remaining in Essex, but ultimately at Foulness Island adjacent to Shoeburyness.

The development of atomic weapons was at that time part of the overall responsibility of the Atomic Energy Council and a requirement was put to the Council in 1948 for buildings to fabricate fissile components for the first atomic device which, to allow time for proving and test preparations, would be needed by the spring of 1951. A former Royal Air Force airfield was selected — the Aldermaston site. It was then being used to train airline pilots but during the war it had accommodated United States Reserve Air Units and gliders which took part in D-Day operations.

The construction of specialised buildings began in April, 1950, with an extremely tight schedule and a working force recruited from many parts of the British Isles. A former RAF hospital was converted into flats to accommodate key staff and other disused buildings were adapted as canteens to serve thousands of meals each day. At its peak the construction force numbered 4,000 men.

The constructional work was equivalent to building a town in an area with negligible transport facilities. In scientific and technological terms, it was the building of a unique complex of laboratories, engineering workshops, stores, assembly and testing facilities, administrative blocks, staff housing estates, amenities buildings, schools; almost anything from reactor buildings to dog kennels — a site of 20 million bricks, 3,500 miles of steel and copper piping and an endless variety of other building materials. The first stage of construction was completed by December, 1951, with the handing over of a 'hot' laboratory. The building of Aldermaston went hand in hand with the production of the atomic test bomb but much remained to be done when the device was successfully detonated early in October 1952.

The test firing in the Monte Bello Islands, north of Australia, was the result of some years of political consideration and exacting scientific research and development. The scientific task was carried out in conjunction with many other research establishments, including Harwell and Windscale, and with British industrial assistance. Finally, the test site was chosen and agreed with the Australian government, within whose territory it is, and it was prepared by Royal Engineers with the help of the Royal Australian Air Force. An expedition was then mounted by the Royal Navy to carry the weapon, workshops, laboratories, hospital facilities, stores and more than 100 scientists and supporting personnel half way round the world.

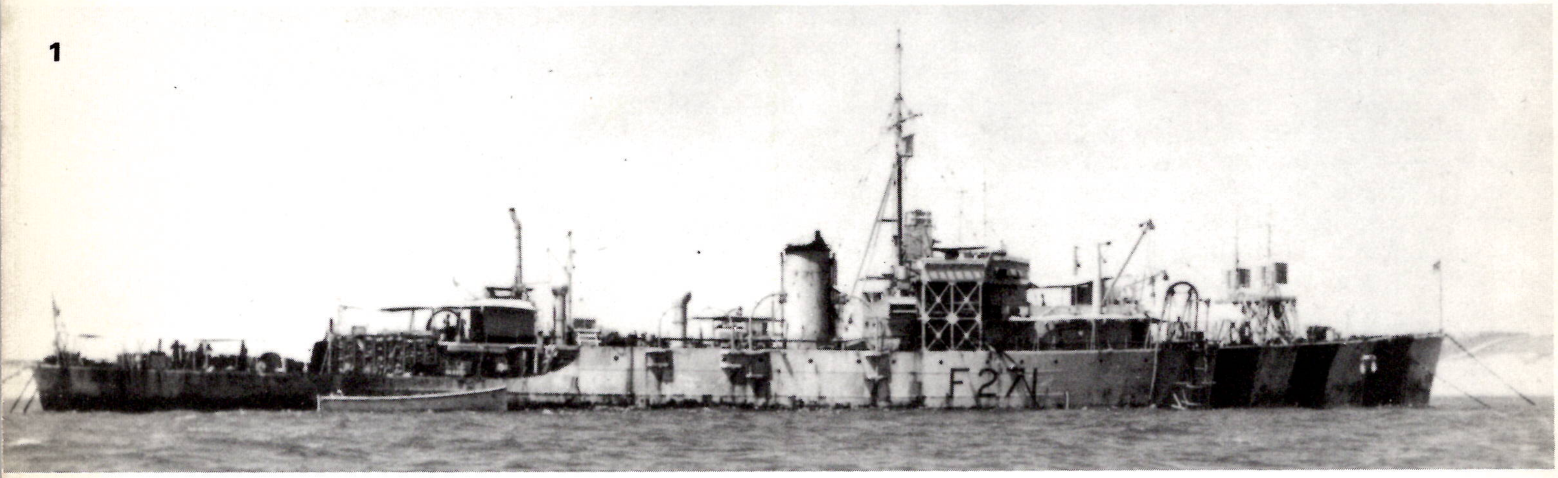
It was an expedition with an aircraft carrier, HMS Campania, as flagship and base for the operation, a frigate, HMS Plym, to carry the bomb in situ and several other British warships. The Plym was vaporized in the searing explosion and as a huge column of water rose in perfect symmetry, the sea trembled as the blast wave struck other ships of the expedition as they lay off at a safe

distance. Britain had become the world's third nuclear power, the Soviet Union having detonated her first atomic test bomb in August, 1949.

After Monte Bello, Aldermaston settled down under the control of the Ministry of Supply to the routine task for which it was established: to meet the long term requirements of the Chiefs of Staff for British deterrent weapons. When the United Kingdom Atomic Energy Authority was established in 1954 it became the Weapons Group within the rapidly developing overall British nuclear programme. In 1973 the weapons task was transferred to the Ministry of Defence.

1 HMS Plym used in the Monte Bello test
2 The airfield site on which AWRE was built

1



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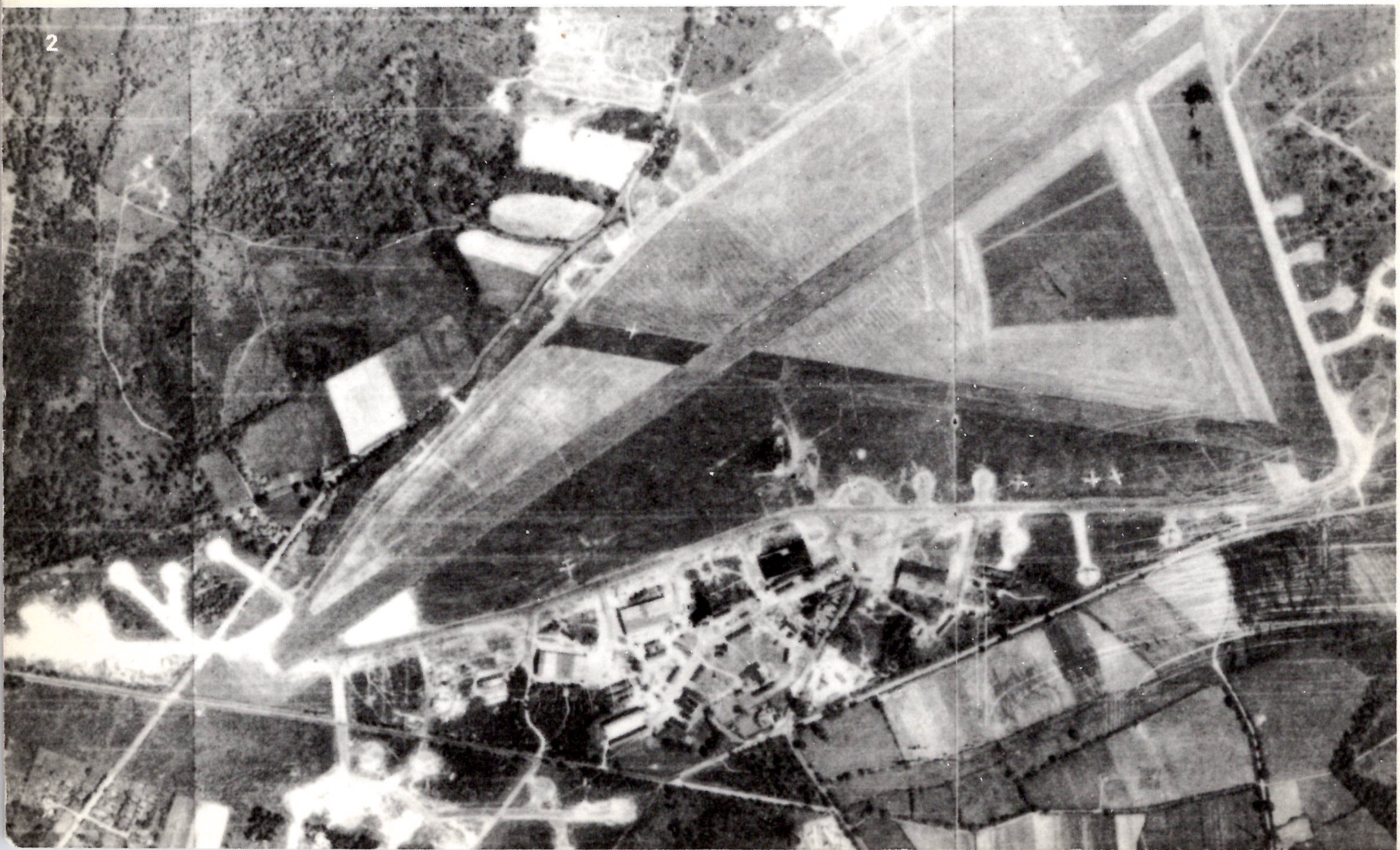
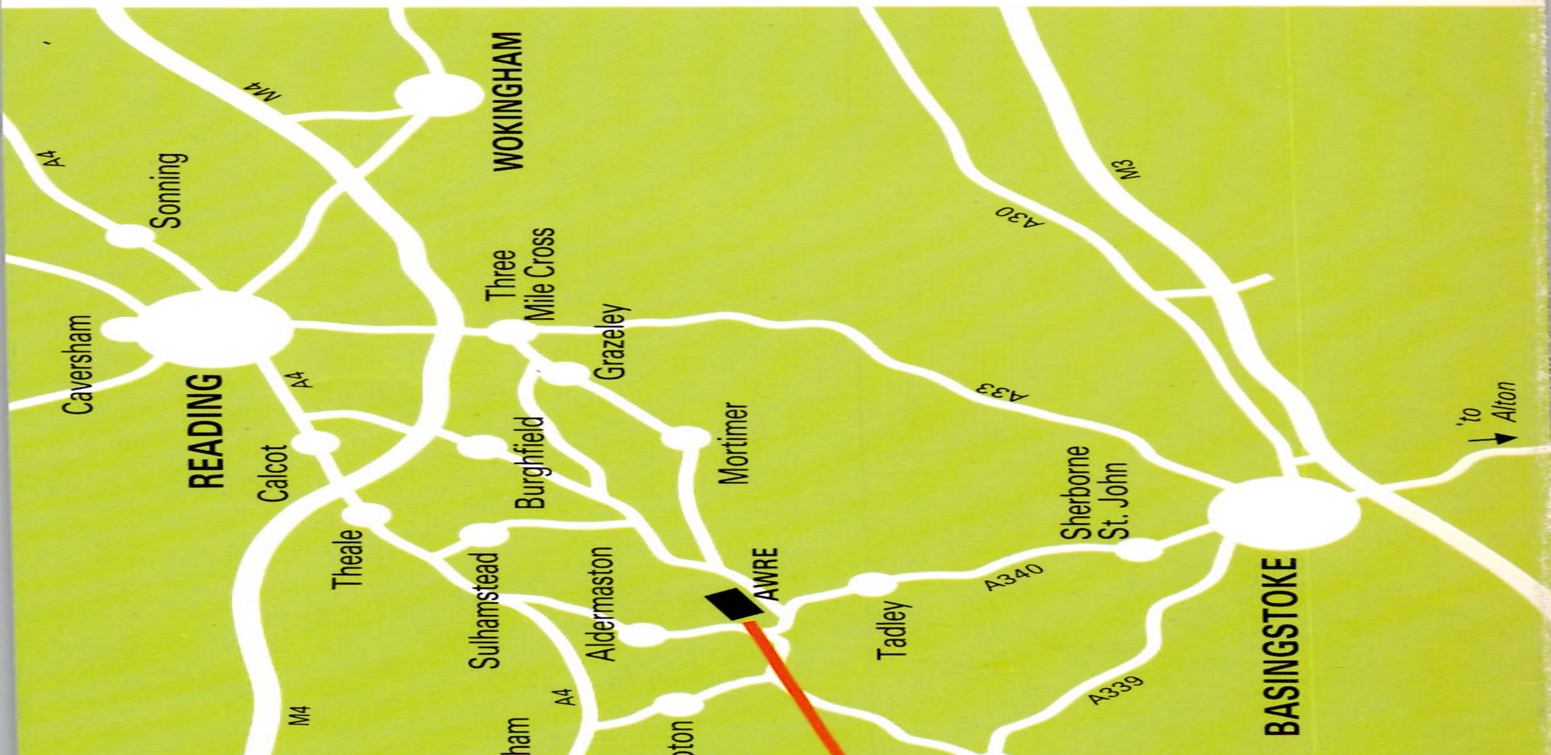


AWRE

Atomic Weapons Research Establishment



TRAVEL

There are frequent train services from London to Reading and Basingstoke. If requested in advance, cars can usually be arranged to meet visitors at these stations. Bus services are also available from Reading and Basingstoke to Tadley.

Front cover:
View into Herald light-water reactor

Back cover:
High heat-rate tensile test

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View across one of the two AWRE lakes